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Helicopter Antitank Weapons System. AH-1Q or OH-58X?

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Final report 6 June 1975

A thesis presented to the faculty of the U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027

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The viability of and the necessity for an antitank helicopter (ATH) is reaffirmed in this unclassified study. The author develops the need for and the feasibility of a relatively small, simple and inexpensive ATH to replace the current and still developmental AH-1Q in its pure antitank role. Key measures of effectiveness criteria are discussed, developed and both systems are then compared and evaluated. Economic comparisons are also used to test the hypothesis: "If combat effectiveness and economic considerations are of paramount importance in the ATH, then modification of existing OH-58A's to OH-58Q's would provide the better antitank weapons system." The author concludes that the OH-58Q with four TOW missiles is the better system.

HELICOPTER ANTITANK WEAPONS SYSTEM: AH-1Q OR OH-58Q?

LEAVEN WORTH

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements of the degree

MASTER OF MILITARY ART AND SCIENCE

by

E. W. CAVANAUGH, JR., MAJ, USA
B.G.S., University of Nebraska at Omaha, 1971

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Fort Leavenworth, Kansas
1975

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Chapter I

INTRODUCTION TO THE PROBLEM

The evolution of the tank and its employment on the battlefield have epitomized the elements of shock, firepower and mobility virtually since its introduction in World War I. Some experts have even stated that it "has dominated the battlefield since World War II." (A6:54) A general review of such ostensibly professional publications as "Military Review," "Army," "Infantry" and others since the mid-1960's reveals that a significant amount of literature has been devoted to the use of and defense against tanks, particularly in the European environment.

"The geographical center and also the key bastion of Western defense is indeed Central Europe." (C11:43) The threat to the North Atlantic Treaty Organization (NATO) in this area is the Warsaw Pact under the auspices of the Union of the Soviet Socialist Republic (USSR). General James H. Polk, then commander of U.S. Army Europe and Seventh Army stated in 1970 that:

> ...the communist armies are bigger and better trained than at any time since World War II. They have the most modern weapons and equipment....In the Soviet zone of Germany, 20 Russian tank and motorized rifle divisions...300,000 men stand fully combat ready....In addition to the Soviet divisions stationed in Eastern Europe, the armies of East Germany, Czechoslovakia and Poland provide 30 additional tank and motorized rifle divisions... (C29:48)

Other unclassified sources present an even more illuminating comparison. The assumption is made that NATO forces have many qualitatively superior weapons; but that numerically there are some significant differences particularly in the tank comparisons. (A5:90)

TABLE 1

Comparison of NATO AND WARSAW PACT TANKS-1973
(Numerical Quantities)

CATEGORY	NATO	WARSAW PACT	(of which USSR)
	Northern and Central Europe		
Main battle tanks in operational service in peacetime	6,500	17,000	10,000
	Southern Europe		
	2,150	6,200	1,700
Subtotal	8,650	23,200	11,700
Reserve/float tanks	1,500	1,000	1,000
France's tanks	810	-	-
TOTAL	10,960	24,200	12,700

(A5:90)

It was because of this numerical advantage that Mr. Stanley R. Resor, Secretary of the Army from 1965 through 1971 noted in his testimony before Congress that the "...NATO forces can never hope to match the massive armored forces of the Warsaw Pact in numbers alone." He went on to place special emphasis on getting the tube-launched, optically-tracked, wire-guided (TOW) heavy anti-tank missile into the hands of the troops as soon as possible. It was visualized that this weapon would be used both in the offensive and defensive roles and would be employed by men on the ground, mounted on ground vehicles and on aircraft. (C17:125) Even though some progress has been perceived in the Strategic Arms Limitations Talks (SALT) and the mutual balanced force reductions (MBFR) talks, the significant threat that the tanks of Warsaw Pact pose to the security of NATO is still a valid one. (C7:49) Studies completed in Europe have demonstrated that an effective antitank

weapon is the helicopter-mounted TOW. The Ansbach Study was a joint United States, German and Canadian free play study and exercise conducted in central Europe in 1972. The purpose of the study was to test the validity of the antitank helicopter (ATH) concept and to develop techniques using helicopters as tank killers. Additional data extrapolated and developed from the Ansbach Trials is contained at APPENDIXES A-E. This information generally validates the ATH concept and is the primary basis for conceptualizing force development and employment of the ATH.

BACKGROUND OF THE PROBLEM

The problem of research, development, test and evaluation (RDT&E) and the fielding of new weapons systems within the current environment appears to be partially the result of worldwide economic interrelationships which impact upon domestic affairs. United States Congressional concerns in recent years have been with the devaluation of the dollar overseas, inflation at home and abroad, balance of trade deficits, unemployment, "Watergate," elections and to an increasing degree, ecology. Congressional concerns with the above problems and particularly with inflation and the dollar have created a growing disenchantment with costly, "exotic" weapons systems designed to provide quantum jumps in technology and sophistication. This situation has had an adverse effect upon the U.S. Army's programs for weapons development and procurement.

General Environment

Inflation is one of the major trends impacting upon procurement. Mr. Malcolm Currie, Director of Defense Research and Engineering, Department of Defense (DOD) estimates that real inflation in the area of research technology dollar costs "...has been 9 to 10 per cent." (E3:5B) Mr. Lee

W. Sheftell, Assistant Director of the Army Budget for Resources estimates that Department of the Army (DA) is "...dealing with inflation rates of 10 to 12 percent." (C13:12) Other Pentagon officials have estimated that there is a funds shortage in excess of $11-billion due to inflation and budget cuts by Congress which was for the planned procurement of weapons and materiels. (E2:1A)

Congressional disenchantment with the rising costs associated with "exotic" DOD and DA major weapons systems may be justified. Unofficial estimates are that "...the Army has invested about $15-billion in research in the last 10 years..." and that the Army "...over an extended period, has failed miserably at the development of effective new weapons and equipment." (E1:23) Using FY72 dollars, examples cited in various periodicals include the main battle tank 70 (MBT 70) which evolved to an estimated unit cost of $600,000. (C17:143) This project then became the XM1 (Abrams) which will cost approximately $507,000. (C16:136) The Advanced Aerial Fire Support System-AAFSS started in 1963 created problems between the Departments of the Army and Air Force and grew from $2.7-million per copy in 1967 to close to $4-million per copy of the AH-56A in 1970. (C17:147) It is currently estimated that the Advanced Attack Helicopter-AAH will cost $1.6-million per copy. (C15:133) Other examples cited include the initial versions of the M-16 Rifle and more recently the heavy lift helicopter-HLH. (E1:23)

The most significant effect or trend that these concerns have generated was reflected by Lieutenant General Robert R. Williams, the Assistant Chief of Staff for Force Development in 1971:

> In viewing the trends for the 1970s [sic], it is apparent that budgets, rather than strategy, will direct the Army's composition, deployment capabilities, manpower, equipment and modernization. (C31:83)

In 1972, then Secretary of the Army Robert F. Froehlke stated,

"Developing and buying the right kind of equipment for the Army is one of the most difficult aspects of our job." (C10:17) General Henry A. Miley, Jr., then Commanding General, Army Materiel Command has amplified this trend in his discussion of the Army's renewed cost consciousness and the resultant "design-to-unit production cost" with its emphasis on "trade-off [sic] analyses" and "design-to-unit-cost." He went on to state that "...the Army and its contractors fully understand that cost is now an equal partner with performance in weapons design and development." (C23: 37-40)

The current Secretary of Defense James R. Schlesinger has reemphasized these concerns.

> A particularly critical area, he said, is how the Army 'deals with the weapons acquisition process--whether it achieves the optimum balance between R&D and procurement, whether it strikes the right balance between pushing the state of the art (and) aiming for numbers, affordability and maintainability.' (C32:38)

Mr. John K. Daniels a management consultant to the U.S. Air Force and within the defense industry since 1956 has provided a slightly different perspective for these trends:

> The current emphasis on design-to-unit-production cost has one significantly worthwhile characteristic: it is providing us all with an unmistakably urgent signal that the national resources allocable to defense systems are severely limited at a time when international military technology and the consumption rates of combat are undergoing revolutionary change. (C5:14)

The comsumption rates of a mid-intensity conflict are part of the information contained in the interim analyses which are still forthcoming from the October 1973 Middle East War. (A6:X) "During this 18-day war the Israelis lost about 4,100 men, 840 tanks and 114 aircraft; the Arab forces lost approximately 14,800 men, 1,875 tanks and 465 aircraft (figures are based on estimates reported in the U.S. news media)." (C27:4) The official dictionaries of the Joint Chiefs of Staff (JCS) and the U.S. Army do not

currently define mid-intensity or high-intensity conflicts. However, they do define conventional forces with conventional weapons and specifically exclude the use of any nuclear and biological weapons. It "generally excludes chemical weapons except for existing smoke and incendiary agents, and agents of the riot control type." (B5:145-150) Consequently, a mid-intensity conflict is one phase below the final escalation to a general war where the total resources of the protagonists are employed and the national survival of one or both is in jeopardy. (B21:78) The Commandant of the U.S. Army Infantry School, Major General Thomas M. Tarpley, has outlined the "...Army's definition of a mid-intensity conflict: nonnuclear, national policy limitations, sophisticated environment, large armored forces, rapidly changing battlefield conditions." (C30:3) Brigadier General James H. Merryman, the former Director of Army Aviation has described the current threat or challenge in the more developed areas such as Europe and the Mid-East as a mid-intensity war. He has transferred the information gleaned from the October 1973 Mid-East War and applies it worldwide:

> ...predominantly armor forces supported by extensive, in-depth artillery. The force thrusts forward quickly under the cover of surprise and an umbrella of a formidable antiaircraft network, pausing only long enough to consolidate ground gains, and reposition antiaircraft weapons before moving on to deep objectives in the exploitation phase. (C22:2-3)

The air defense umbrella used in the Mid-East War consists of weaponry available to the Warsaw Pact. (B77:1-72) It presents a significant threat to any type of aircraft flying near or in the forward edge of the battle area (FEBA). (A6:26,52-55) General Thomas M. Tarpley has stated that:

> The survivability of Army aircraft in a mid-intensity environment is a question that can only be answered by determining aircraft susceptibility to hostile weapons systems and the capabilities of the enemy's soldiers to employ them. (C30:2)

This information adds yet another dimension to the already complex

problem of weapons development, procurement and utilization. Prior to the Mid-East War, Army planners had realized that budgetary constraints would result in smaller purchases of the Army's "Big Five" developments. However, it was believed that these superior technological developments would still allow them "...to fully replace predecessors which are now deployed in far larger numbers." (C15:126-127) Since the Mid-East War and its continuing analyses, it has become apparent that a conflict in the European environment would also result in extensive losses of men and materiel.

Although General Hamilton H. Howze, the former Director of Army Aviation and "...the intelluctual force behind airmobility and Army aviation doctrine...." accepts the "...trend towards greater sophistication and complexity..." in aviation, he does suggest that some consideration be given to other alternatives. (C12:6-7)

> Against the admittedly powerful and attractive considerations of aircraft performance and safety, at high unit cost, are the less appealing considerations of simplicity and greater numbers at much smaller unit cost....cannot most of these missions be accomplished by cheaper aircraft?...I do believe that there should be a smaller and somewhat simpler type to supplement the big busters....Large and complex items of equipment tend to filter back from the forward edge of the battle area into higher echelons of command. This will hold true for helicopters that are hard to hide and hard to maintain without special equipment. If the Army's maneuver battalions are not to lose the enormous battle advantages bestowed on them by quick, responsive, light aircraft, some of those aircraft had better be of a size and configuration enabling them to live up there with the tankers and doughboys and cavalrymen, in the mud and under the trees. (C12:7)

There are a large number of key factors that impact on this problem. Inflation and its impact upon the costs of highly complex and sophisticated equipment is one of the major concerns. The renewed cost consciousness resulting in the concept of "design-to-unit production cost" which may result in trade offs between performance and cost and the average lead time from concept to production of about eight years is significant. (C17:121-151) The mid-intensity fighting, formidable air defense umbrellas

and extensive materiel losses resulting from a mid-intensity conflict have resulted in some consideration being given to procuring lower cost, simpler aircraft in larger quantities. DOD and the Army's sister services have started using a "hi-lo" force mix concept. (B43:222-223) This concept of a limited number of sophisticated weapons systems supplemented by more numerous simple systems is typified by Secretary Schlesinger's October 1974 statement at the Annual Association of the U.S. Army meeting.

> In weapons procurement, he said, 'quality...is not the whole story. When Daniel Boone, who shot 50 bears a year, was replaced by 50 hunters who averaged two each, the bears saw no occasion to celebrate the decline in human marksmanship.' (C32:38)

Other concerned personnel have expressed the same concept in different terms:

> ...it is much better to build a force on a large number of simple, cheap items than a small quantity of exotic, expensive ones. The doctrinal corollary to this is: deploy weapons in great depth by expanding the basis of issue. Precision weaponry is advancing so rapidly that multiple-attrition is inevitable, so why not maximize the odds of having something left to fight with? (Apropos of this axiom, another look at the rationale for future tanks, air defense weapons and helicopters might be particularly instructive.) (C13-12)

> In summary, we resolve the argument between quality and quantity on the side of quantity - with reservations. Given the opportunity for an equal-cost trade-off between a new piece of equipment representing a 'breakthrough in sophistication' and just a 'better' simpler item, we would take the 'better' - and more of them and with more training. Furthermore, we believe that an increasing number of military professionals are coming to agree with this point of view. (C21:P12-8)

This background of the general environment of inflation, Congressional disenchantment with weapons systems costs, and the mid-intensity conflict consumption rates have apparently contributed to the development of DOD's "hi-lo" force mix concept. These factors also appear to have had some effect on the development of professional discussion on weapons systems procurement concepts which include the ATH.

ATH Concepts

There are generally two concepts regarding the configuration and degree of specialization required for the ATH. TABLE 2 depicts some of the real differences between the relatively large, expensive and sophisticated multipurpose AH versus the relatively smaller, less expensive and simpler ATH concepts.

Background. The French have been credited with pioneering the initial use of helicopters with antitank guided missiles (ATGM's), fixed machine guns and hand-held door guns in Algeria in the mid-1950's. (C20:9) TABLE 3 provides information on the ATGM's currently in use by the Free World nations.

The U.S. Army contracted for the UH-1B Iroquois in December 1960 and received the first delivery in December 1961. It was designed with universal pylons to serve as mounts for weapons or external fuel tanks. Later gun platform developments included the UH-1C with the 540 rotor system. (B13:1-59 thru 1-68) The concurrent development of the AH-56A Cheyenne and the fielding of an interim armed escort for immediate use in Southeast Asia, the AH-1G Hueycobra, were Army aviation highlights in the mid-60's. (B18:178,247) In Fiscal Year 1968 (FY68), the AH-56A program was expanded to serve in the antitank role. (B19:233-234) This trend towards large, multipurpose attack helicopters-AH's was reinforced with Congressional procurement approval of the first 15 AH-56A's in FY69 and DOD's request for a "total package" contract for 375 Cheyenne's during the next three-years. (B3:80-84) In FY72, DOD requested $4-million to begin advance production engineering (APE) for equipping Cobra's with the TOW and $13-million for continued development and APE of the Cheyenne. (B31:91-92) Faith in the TOW-helicopter system was substantiated in hearings before

Congress by Lieutenant General John R. Deane, Jr. the former Army Chief of R&D after three crews were pulled off the Cheyenne development and sent to Vietnam three-days later:

> The TOW weapon system has performed extremely well under actual combat conditions. In Vietnam during the period May 2-June 30, (1972) TOW was credited with a total of 59 kills, including 30 tanks. To date, TOW has demonstrated effective system performance. (B108:374/C14:128)

Current Large Antitank Helicopters. The U.S. Army is continuing production of the relatively large (9,500 pounds) and specialized AH-1Q TOW-Cobra as an interim ATGM weapons platform for the $1.7-million per copy, much larger (15,100 pounds), AAH. (C16:133) It should also be noted that the "AAH will be smaller, lighter, less complex, and much less expensive than the Cheyenne." (B111:449) Other nations which have chosen the larger, multipurpose AH include Iran (Bell Model 309 Kingcobra) and the European Communist countries (Mi-24 Hind A). (A7:121,263-264/B78:15-85) See TABLE 2 for AH-1Q comparisons with other free world nations; helicopters.

Current Small Antitank Helicopters. Possibly for economic reasons, the Germans, French, British and Italians have chosen the smaller (3,747 to 5,070 pounds) multirole helicopters with weapons systems which "button-on" as required. Consequently, their helicopters are used for command and control, reconnaissance and utility functions as well as in the attack role. (B78:8-9)

The Germans stress that the tank destroyer gunship (TDC) should have a small profile, low noise level, high maneuverability, two to three-hour endurance, twin-engine power and safety, night and weather capabilities. (B84:5-9) Another author stresses:

> a simple, small, inexpensive...narrow silhouette, two power plants and sufficient arms. The obvious basis for the technological requirement might be illustrated by the old saw: 'A swarm of wasps bites oftener than a hornet.' (B82:2)

TABLE 2

Representative Free World Helicopters-1972

	U.S. (A) AH-1Q TOW-COBRA	F.R.G. (B) BO105 HOT	FRANCE (C) SA 316 ALOUETTE III	U.K. (D) SA 341B GAZELLE
ATGM: (number & type) (also see TABLE 3)	2-6 TOW	6 HOT	4 AS.11 or 2 AS.12	4 AS.11 2 AS.12 or 4 HOT
DIMENSIONS: (feet-inches)				
Diameter of main rotor	44-0	32-2 3/4	36-1 3/4	34-5 ½
Diameter of tail rotor	8-6	6-2 3/4	6-3 ¼	2-3 ½
Length of fuselage	45-2	28-0 ½	32-10 3/4	31-2 3/4
Overall height	13-9 ½	9-9 3/8	9-10	9-0 ¼
Max cabin width	3-2	4-7	8-6 ¼	4-5 ¼
AREAS: (square feet)				
Main rotor disc	1,520.4	815.8	1,026.1	931
Tail rotor disc	56.8	30.5	30.9	4.1
WEIGHTS: (pounds)				
Operating weight	6,630	2,360	2,500	1,947
Mission weight	9,734	4,629	VARIES	VARIES
Max T-O & landing	9,500	5,070	4,960	3,747
PERFORMANCE: (mph; feet/minute; feet; miles; hours:minutes)				
Max permissible speed	219	155	136	192.5
Max rate of climb @ S/L	1,230	1,870	885	1,615
Service ceiling	11,400	13,450	13,125	15,100
Hovering ceiling IGE	9,900	7,610	7,380	10,500
Max range @ S/L max fuel, (8% reserves)	357	363 (0%) 621*	298 (0%)	416 (0%)
Endurance @ S/L no reserves (hours:minutes)	1:30	5:45* *w/auxiliary tanks	Unknown	Unknown

ALL (A7:43-263,562-579)
(A) (B13:1-18 thru 1-24/B16:X/F3:X)
(B) (C24:94/B80:5-9)
(C) (C9:15)
(D) (C3:59)

The French stress small size, excellent observation characteristics supplemented with optical observation equipment and power (albeit single engine). (C9:15) The British under an Anglo-French agreement are building the SA 341 Gazelle which has two 7.62mm machineguns in addition to the ATGM's listed.

TABLE 3

Free World ATGM's - 1972

ACRONYM	GUIDANCE SYSTEM	WEIGHT* (pounds)	RANGE (meters) MINIMUM	MAXIMUM
TOW	optical/wire	48	65	3,000#
HOT	" "	62	75	4,000
AS.11	" "	66	500	3,000
AS.12	" "	167	UNK	5,500- 8,000
SWINGFIRE	UNK	UNK	300	4,000

(A7:562-579)

* Weight of missile and warhead only, does not include pylon(s) and launchers.
#Extended range version of the TOW successfully "scored hits at ranges that varied from 3,500 to 3,750 meters." (C25:91)

Our European Allies configurations of the ATH have been briefly outlined. It is interesting to note that all versions are designed to carry two to six ATGM's. Even within the United States the concept of a smaller ATH has been supported by an Ansbach Trial recommendation that "...development efforts should strive to provide anti-armor helicopters that: (a) are smaller than the AH-1G, especially in side presentation..." (B80:21) One of the best and most concise verbalizations of this smaller sized concept was made by Major Robert S. Fairweather, Jr. in March 1973.

> To do the job in future battles, we need a small, highly maneuverable gunship that can carry heavy ordnance loads at all airspeeds at low altitudes. It should be "over-built so that most bullet hits can be disregared or easily patched. It should have a twin-engine power plant (power and safety), a rigid-rotor system (stability), the fewest hydraulic and electrical components (reliability), good cockpit visibility (especially for night) and protection, a wire-cutting and small tree-chopping capability, and a reliable instrument flight package. Its weapons should include a true fire-and-forget antitank missile system, a 20-mm cannon and a reliable anti-personnel gun system. The fire-and-forget system should be a simple one, such as a highly accurate ballistic rocket which has a good probability of first-round kill.
>
> I think that until we can design and field such a gunship we should consider building a very large fleet of expendable light obervation

> helicopters (LOH) equipped with TOW systems. The Soviet bloc stresses gaining the advantage of mass on the battlefield. To lower this advantage, we must be ready to kill large numbers of tanks. Even if each LOH can kill only one or two, we can build the machine at lower cost than we can a tank. (B78:8-35)

The value of a small ATH was analogously supported by DA witnesses during the FY 74 Congressional hearings on DOD appropriations. When questioned on the possibilities of using the AAH or the Utility Tactical Transport Aircraft System (UTTAS) in the aerial scout/LOH role to save development and production costs, the Assistant Secretary for Research and Development (R&D) Mr. Charles L. Poor followed by Lieutenant General W. C. Gribble, then Chief of R&D replied:

> Our Southeast Asia success with the Scout helicopter indicated that it should be small and highly agile. While the advanced attack helicopter will weigh from 11,000 to 16,000 pounds, we envision a much smaller and lighter aircraft to perform the aerial scout mission--one which weighs 5,000 pounds or less...Although the AAH could possibly be used as an aerial scout, it appears that it would be much more costly and less efficient than a smaller helicopter optimized for the Scout mission. (B108:351-352)...The UTTAS will be too large to perform the observation and reconnaissance missions now being performed by the LOH. The small physical size and maneuverability of the LOH have proved invaluable in Vietnam." (B108:541)

Other sources have stated that "Even a Huey (UH-1 Iroquois) is needlessly large and lacks the extreme maneuverability desirable for low level missions." (B79:8-27) It should be noted that the UTTAS and the UH-1 are roughly comparable in size although not in performance.

The following table depicts the relative size and weight differences between the aforementioned aircraft. The agility and maneuverability aspects will be discussed later. TABLE 4 clearly shows that the UH-1H and the AH-1Q are roughly equivalent in size and analogously by the previous statements are not entirely suitable for low level missions. The OH-58A was used as a scout helicopter and for a variety LOH missions in Vietnam and is relatively smaller than the other helicopters.

TABLE 4

Helicopter Size and Weight Comparisons
(Percentage Differences Between the AH-1Q and OH-58A)

	(A*)AH-1Q	(±%)	(B*)OH-58A	(±%)	UH-1H(C*)
A. DIMENSIONS: (feet:inches)					
1. Diameter of main rotor	44-0	(+20%)	35-4	-	48-0
2. Diameter of tail rotor	8-6	(+39%)	5-2	-	8-6
3. Length of fuselage	45-2	(+29%)	32-2	-	41-10¾
4. Overall height	13-9½	(+30%)	9-7	-	14-6
5. Maximum (Max) cabin width	3-2	-	4-2	(+24%)	8-7
B. AREAS: (square feet)					
1. Main rotor disc	1,520.4	(+36%)	978.8	-	1,809
2. Tail rotor disc	56.8	(+65%)	19.7	-	56.7
C. WEIGHTS: (pounds)					
1. Operating weight	6,630	(+65%)	2,313	-	5,557
2. Mission weight	9,734	(N/A)	VARIES	N/A	9,039
3. Max T-O & landing	9,500	(+68%)	3,000	-	9,500

*FOOTNOTES ALL: (A7:259-264)
(A): (B13:1-18 thru 1-24/B16:X/F3:X)
(B): (B13:1-55 thru 1-56/B17:X)
(C): (B13:1-69 thru 1-78)

<u>ATH Concepts Summary</u>. The recognition of the threat forces in Central Europe has caused the majority of the free world (non-communist) nations to field antitank guided missiles (ATGM's) with some mounted on helicopter platforms to counter the Warsaw Pact threat. (A7:43-579) These free world moves apparently resulted in the European Communist Bloc nations converting existing helicopters such as the Mi-24 Hind A to antitank gunships. (B78:15-85/A7:590-591)

The United States and a few other nations have decided that the current relatively expensive and sophisticated AH with ATGM's and its successors should be a multipurpose weapons system in a comparatively large

configuration. The U.S. Army is continuing to test and develop doctrine to take full advantage of the AH's multipurpose firepower, mobility and flexibility. (D4:X/F2:X) Conversely, and probably due to economic reasons the Germans, French, British and Italians have opted for the nonspecialized, comparatively smaller configuration of a "button on" weapons system ATH to accomplish essentially the same antitank mission with similar ATGM's. (B82:4) These countries and others, to include various United States authorities have inferred or stated explicitly the necessity for considering a smaller version of the ATH.

STATEMENT OF THE PROBLEM SITUATION

The most significant threat facing the United States and its allies in Europe is the Warsaw Pact. One of the obvious weaknesses in our defenses is the numerical (quantitative) superiority of tanks which the opponent possesses.

AH-1Q Shortcomings

Field studies have proven that the helicopter-mounted TOW is an effective antitank weapons system. (B80:X) The Ansbach Trials revealed that a viable method to counter the threat would be anti-armor helicopters that "should kill fifteen or more enemy tracked vehicles per missile-firing helicopter lost." (B80:20) The U.S. Army is currently converting AH-1G Cobra attack helicopters to antitank weapons systems. However, studies in 1971 and 1973 showed that the AH-1G had to be limited in gross weight in order to operate safely. (B57:X/B58:X)

> ...The attack helicopters (AH-1G's) used in the experiment weighed approximately 8000 pounds with full fuel load, crew and instrumentation. The aircraft operated during summer months when the temperature often reached 100° Fahrenheit. Taking into consideration temperature, density altitudes, and aircraft basic weight the aircraft was operating at very near maximum gross weight for such conditions. This

> operating capability would approximately match the conditions of a European, mid-intensity conflict with aircraft operating at lower temperatures, but carrying a full load of armament. Thus, the aircraft flown during the AIRCON experiment possessed nearly the same weight configuration that is foreseen for actual European conditions. (B57:32)

This weight limitation poses problems for a weapons system conversion which was originally designed to have a payload up to eight TOW missiles. It is designated the AH-1Q and is an interim measure to fill the perceived gap in the NATO defenses as soon as possible.

It should be noted that..."the single-engine AH-1Q will still be something of a marginal performer. In fact, with full fuel tanks and a load of 40-mm projectiles and machine gun ammunition, the Cobra will be able to carry four TOWs [sic]." (C15:133) The Secretary of Defense James R. Schlesinger corroberated this information in his FY 75 Budget Statement to Congress when he stated that: "The AH-1Q as presently configured can carry 2 to 6 TOW's (depending on the weather and altitude) in addition to its other armament and fuel load." (B43:108) What is not commonly known is that the AH-1Q is frequently limited to a maximum weight of 7900 pounds for improved performance. This is accomplished <u>by removing all weapons systems</u> except 4 TOW's and by limiting fuel to 920 pounds. Fuel endurance remains 1.5 hours and it can now hover out of ground effect (HOGE) in 95°F at 3000 feet density altitude. (F3:X) An article published in April 1975 on the performance of the AH-1G which is converted to the current AH-1Q revealed that with a full fuel load of 1716 pounds, the ordnance pay load is extremely limited. The limitations vary with altitude, temperature and desired performance capabilities. For example, in order to achieve a 300 feet per minute vertical rate of climb at sea level on a standard day of 59°F, the ordnance payload must be limited to 1044 pounds. In order to achieve the same performance at 2000 feet and 70°F, the ordnance payload must be limited to 824 pounds. In order to hover out of

ground effect at 4000 feet and 95°F, all ordnance must be removed and the fuel decreased by 506 pounds. (C1:2) Naturally, fuel could be traded off in each instance to improve performance; but the cost is a further decrease in the AH's current 1.5 hours flight endurance capability. Considering the fact that the Q conversion with eight TOW's weighs 1228 pounds it becomes obvious why the U.S. Army has gone to the weight constrained version of the AH-1Q. (TABLE 5)

The AAH "... production decision will not be made until 1978-79." (C15:127-133) Production should commence shortly thereafter. Due to cost constraints, the AAH fleet is currently programed for only 472 aircraft. Consequently, the AH-1Q will be in active service through 1980 and will probably continue to have a primary role decreasing to a supporting role through the mid-1980's until a sufficient number of AAH's are in the field. (C15:133) The total number of Cobra's approved by Congress to be converted to AH-1Q's is 298. Are these numbers adequate to counter the Warsaw Pact threat?

European Scenario

The following scenario is designed solely to depict the necessity for increasing the numbers of ATH's currently programed in order to more effectively counter the Warsaw Pact threat in Europe. The assumptions and results are obviously unrealistic or idealistic and clearly favor NATO.

Using the Bell Helicopter Company's 18:1 ratio for the purposes of this example and falsely assuming that all of the aforementioned AH-1Q's are deployed to Europe, that they are all indestructible until a conflict develops and that they are all flyable on the day the war starts (when indestructibility ceases); theoretically, out of the estimated 24,200 tanks that the Warsaw Pact currently possesses (B43:90), 5364 tanks or roughly 22-percent and ALL of the 298 AH-1Qs that are programed for delivery in the

near future would be destroyed. The current analysis of both the threats T-62 tank and the U.S. Army M60A1 tanks is that they possess a 50-50 chance of achieving a first-round hit against each other at the 1000-1500 meter ranges. The M60A2 is replacing the M60A1 on a one-for-one basis. The M60A2 and M551 have a 3000 meter range which provides some advantage over the threat forces. (D1:A-1 to A-7) Arbitrarily assuming that the U.S. Army's equipment would provide a 10-percent advantage to the combined NATO and France's tank forces; these 10,960 tanks could account for 14,467 or 60-percent of the threat tanks. Thus, 82-percent or 19,831 tanks of the threat force would have been destroyed, leaving only 4,369 of the enemy's tanks to be destroyed by the ground forces, tactical air and artillery. All of which are outnumbered with the latter being outranged by the threat forces. The author does not consider the 298 AH-1Q's currently programed adequate enough to guarantee victory in the European Theater.

Continuing the scenario, it is assumed that Congress approves the FY 75 request for 300 improved Cobra's. The improvements consist of increasing the power of the current engine and changing the gear box and transmission. (B43:109) This would result in a total of 598 AH-1Q's being fielded during the FY 1975-79 period. It is further assumed that the numbers of tanks and other forces for both sides have remained the same and that there have not been any technological breakthroughs for either side. By roughly 1980, this situation would result in the 100-percent destruction of the proposed 598 AH-1Q's who would have theoretically destroyed 10,764 or 45-percent of the current threat tanks combined with the 60-percent killed by the friendly tanks. An overkill of roughly 5-percent would have been achieved. This would allow the numerically inferior ground, tactical air and artillery forces to continue the battle without fearing any further armor threat.

Using the same assumptions, the situation would dramatically improve by roughly 1985 when the 472 AAH's are scheduled to be in the field. (C15: 133) If the U.S. Army's experience with the main battle tank, the AH-56A Cheyenne and the Heavy Lift Helicopter (HLH) are an indicator, the AAH delivery could conceivably slip to roughly 1995.

The point of the scenario is that the threat exists now and that paper requests and programed deliveries do not counter the threat. Consequently, alternatives to counter the threat now or in the near future should be developed. Secretary of the Army Howard H. Callaway's recent statements concerning personnel are also applicable to the ATH: "In any future war that we can envision, there will be no time to recover from a Dunkirk or a Pearl Harbor. We need a ready active force and reserves available only a few days later." (C13:40)

This background information clearly shows that a treat exists now, that there are divergent viewpoints on the configuration of an ATH (large, specialized and expensive versus small, generalized and cheap); that the current procurement of AH-1Q's (a marginal performer at best) is probably inadequate even under the most ideal and unrealistic conditions; and that an alternative approach should be considered, if not required.

ALTERNATIVE FEASIBILITY

One possible alternative is converting the OH-58A to an ATH. This thesis is somewhat experimental in that extensive research has failed to uncover any unclassifed, documented cases of the TOW missile being fired from a LOH platform. There are numerous inferences to and the author has personal knowledge of the scout helicopters in the Republic of Vietnam being equipped with a variety of weapons systems to include the nonstandardized door-mounted M27 miniguns augmented with an M-60 machine gun and a ".50

caliber starlight scope"; a 2-tube experimental 2.75 inch rocket launcher used for marking purposes which eventually evolved into a 7-tube, 2.75 inch rocket launcher with 17-pound warhead rockets and other less exotic small arms or machine gun combinations.

The Brazilian Air Force has purchased seven Bell Model 206A Jet Rangers (OH-58A's) and converted four of them for counterinsurgency operations. These four OH-58A's are armed with a 4-tube M2A2 launcher for 2.75 inch rockets mounted on the aft edge of the left door and a .50-inch caliber machine gun mounted on a flexible mount by the right door. (A7:259)

Weight Feasibility and Comparisons. The following table depicts the differences between the standard AH-1Q and its weight constrained configuration and the OH-58A and its proposed conversion to an OH-58Q. Table 5 clearly shows that the OH-58Q is feasible from a weight standpoint and that it would have the same payload of 4 TOW's as the weight constrained AH-1Q.

TABLE 5

Weight and Feasibility Comparisons AH-1:OH-58

ITEM	AH-1Q w/M28A1	AH-1Q* w/o M28A1	OH-58A w/o M27E1	OH-58Q
Basic Weight	5738	5612	1464	1464
M65 Q Provision	492	492	N/A	492
Q BASIC WEIGHT (wt.)	6230	6104	1464	1956
Crew (2)	400	400	400	400
OPERATING WT.	6630	6504	1864	2356
Trapped Fuel/Oil	64	64	N/A	11
TOW Pylons @ 42 (2)	84	84	N/A	84
TOW Launchers @ 30 (8)	240	(4) 120	N/A	(4) 120
40mm Drums	75	-	N/A	N/A
7.62mm Drums	63	-	N/A	N/A
Fuel	1716	922	475	223**
SUBTOTAL	8872	7694	2339	2794

TABLE 5 (continued)

ITEM	AH-1Q w/M28A1		AH-1Q* w/o M28A1	OH-58A w/o M27E1		OH-58Q
SUBTOTAL	8872		7694	2339		2794
Disposable Ordnance						
TOW @ 51.5 (8)	412	(4)	206	N/A	(4)	206
40mm ammo (250)	190		-	N/A		-
7.62mm ammo (4,000)	260		-	N/A		-
MISSION GROSS WT.	9734		7900	2339		3000
Maximum Allowable Gross WT.	-9500		*7900	3000		3000
OVER GROSS	234		--	--		--
	(F3:X)		(F3:X)			

*AH-1Q: Weight constrained version provides hover out of ground effect (HOGE) at 95° at 3000 feet (ft.) with 1.5 hours (hrs.) fuel duration. (F3:X)

**OH-58Q: Mean fuel duration is computed to be 1.45 hrs. (A7:260/B17: 1-58,12-14) Flight test HOGE at max gross wt. at 95°F is 0 ft.; at 59°, 3900 ft. (B115:B-1)

Temperature Effects. The OH-58Q's performance at maximum gross weight based on service evaluations is degraded in comparison with the weight constrained AH-1Q in tropical temperatures. However, this does not appear to be too significant because the Federal Republic of Germany's "average temperature for January, the coldest month, varies from 27° to 34°F" with cooler temperatures in the highlands. "July temperatures average from 60° to 66°F" and are "slightly higher" in some of the sheltered river valleys. (A3:44-69) Mathematically, the mean temperature is 47°F. The manufacturer states that the OH-58 can HOGE at 6000 feet and HIGE at 13,600 feet on a standard day. (A7:260) Similarly, the same manufacturer states that the AH-1 has an unknown HOGE and an HIGE of 9,900 feet. (A7:263) At lower temperatures, both aircraft could hover proportionately higher and at higher temperatures proportionately lower.

M65Q Provision. The M65 Q Provision (492 pounds) which is required to convert the AH-1G to the AH-1Q TOW/Cobra consists primarily of modifying

the wing stores to support the TOW's and minor modifications to prevent blast damage to the fuselage. Other equipment includes a telescopic gyro-stabilized sight, guidance and control equipment, cockpit displays and controls for the gunner and pilot. It is currently being redesigned to make it 126 pounds lighter which would further improve the performance of both aircraft. (F3:X)

It is assumed that there would not be any significant problem in mounting the TOW pylon consisting of two-launchers and two-missiles which weighs a maximum of 191 pounds. This is particularly true on the left side of the OH-58A since the M27E1 system weighs 234 pounds and: "Complete internal provisions are incorporated in the production aircraft to accept the armament subsystem without modifications." (B13:2-65)

It is further assumed that significant modifications would not be required on the right side of the aircraft due to the fact that the systems weight is the only consideration and recoil does not appear to be a problem. This assumption is corroborated by the Brazilian Air Forces use of a .50-inch caliber machine gun mounted by the right door. (A7:259) In fact, there does not appear to be any problem with recoil from the TOW in that one expert considered it the "smoothest missile" he had ever fired. Colonel Canedy considered it even smoother than firing one-pair of 2.75-inch rockets. (F2:X) The previously mentioned seven-tube rocket launcher (approximately 426-pounds) was also mounted on the right side of the LOH in Vietnam.

If this alternative were accepted, it is entirely probable that the TOW pylon weight would be reduced in weight since it would only have to support two-TOW's (103 pounds) vice the four-TOW's for which it was originally designed. This same rationale would also be applicable to a weight reduction in the launchers to a limited degree.

The OH-58Q concept is viable from a weight standpoint. There do

not appear to be any significant problems which would require additional costs for major modifications in order to provide structural supports for this proposed TOW system. Recoil does not appear to be a consideration. There are already programs underway to further reduce the weight of the current system and it is probable that other logical weight reductions could be accomplished which would further increase its payload and range.

THESIS PROBLEM STATEMENT

The purpose of this thesis is to determine which aviation platform would be the better antitank weapon alternative; the AH-1Q Cobra or the proposed OH-58Q. Restated in slightly different terms, the thesis problem statement is to determine "Which aviation platform would be the better anti-tank weapon system: the AH-1Q or the OH-58Q?"

Importance of the Study

The information presented thus far on the current environment and the problem situation is sufficient reason to research other alternatives to the AH-1Q in developing an appropriate ATH to meet the Warsaw Pact tank threat.

Scope and Delimitations of the Study

The scope of this study is limited to the above Thesis Problem Statement. Other delimitations include:

1. Time Available: The attempt to properly research and to complete a Master's level thesis within a limited time-frame while concurrently participating in other, full-time academic requirements is considered to be a limitation on the time available to conduct research, to prepare and to finalize drafts and to submit the finished thesis in accordance with the submission schedule.

2. Access to resources: Due to the time available constraints, research is largely limited to secondary sources available in the library of the U.S. Army Command and General Staff College and libraries of agencies located at Fort Leavenworth. Primary sources are largely limited to this geographical area for the same reasons. This is considered to be a limitation on the resources available. Because the sources available are limited to the local area, or the sources may not be available through interlibrary loan; this situation is considered to be a study limitation.

3. Aircraft Survivability Computer Models: Current programs are inadequate to conclusively prove or disprove the superiority of one aircraft over another for any given task or mission in a mid-intensity environment. This unreliability is due to the program complexity required to adequately incorporate the objective and subjective input categories, subcategories, and factors impacting on these inputs associated with the environment, enemy forces and friendly forces. (D2:1-1 thru 7-1/APPENDIX F) This is considered a limitation on the ability to cross-check logical conclusions derived from commonality matrixes, surveys and recent literature on the subject.

4. Classification: Due to the fact that the author has chosen the unclassified format, it is conceivable that some of the more significant classified aspects or results of other research and field studies will not be available for publication. In order to preclude any inadvertant disclosure of classified material, research was limited solely to unclassified sources. This is considered to be a limitation effecting the accurracy of the study.

5. U.S. Army Technical Manuals (TM's): Aircraft characteristics will be extracted to provide commonality for comparison purposes. Excluding size (height, length, width), the TM's characteristics are typically averages of the fleet; consequently, there is degree of error involved in

comparing items such as speed, range, payload, weapons configuration, fuel consumption, time on station, offensive and defensive armament, maneuverability, communications and the more subjective area of maintenance hours per flying hour (logistical considerations), visibility, vulnerability and survivability. The unclassified performance data is based on design specifications vice flight tests. This is considered to be a limitation on the accuracy of the findings because of using TM estimated data or manufacturer's claims instead of actual primary source data from the field which is frequently classified in nature.

6. Economic Analysis: An elementary economic analysis will be used for the purposes of this thesis. Due to the fact that both aircraft are already in the inventory; the RDT&E costs will not be considered, U.S. Army publications will be used to determine acquisition costs, to determine the crew and maintenance training costs and to determine logistical operating costs. The unclassified Ansbach Study (B80:X) will be used to extrapolate kill ratios and costs for comparison analysis. To facilitate computations and still retain relative cost comparisons, an arbitrary $5 per maintenance man-hour (M/H) which includes both direct and indirect (40-percent of direct M/H costs; $500), 30-days salary for enlisted personnel and a $1000, 30-days salary for officers will be used.

7. The question of how many actual antitank helicopters are required to counter or to overcome the tank threat is beyond the scope of this study, consequently it will not be addressed.

8. Limited tactics: The helicopters will be limited to a primary tactic of "popping up" (or moving from a covered and/or concealed position) to roughly a three-feet stationary hover above the terrain, fire its missile(s) and then "pop down" (or move rapidly into a covered position). This limitation is necessary to legitimately use statistical data from field tests

which were restricted to ground and vehicular employed TOW's. (B72:X thru B76:X) This limitation will increase the probability of the helicopter winning a variety of engagements against enemy weapons systems based upon the review of the multifarious field tests, computer simulations and mathematical models listed in the bibliography.

9. Other variables: The variables which characterize the performance of an individual weapon are dependent on the specific situation, terrain and other environmental factors. (B78:1-8 thru 1-14).

> The task of planning a force structure and doctrine for advanced weapons is complicated by the many interactions among combat-unit performance, individual weapon performance, battlefield environment, tactical doctrine, and unit organization variables. (B78:1-8)

Due to the broad and essentially unquantifiable nature of these interactions; only the effectiveness elements of combat logistics and personnel will be used for comparison and evaluation purposes.

Assumptions

The following assumptions are considered necessary to further limit the scope of the study in that:

1. There are no legal constraints in transferring approved funds from the AH-1Q or AAH program to a proposed OH-58Q program.

2. An elementary economic analysis will be adequate for the purposes of this thesis.

3. Both aircraft are piloted by aviators of equal weight, target acquisition and flying capabilities, training and experience. That they are equally qualified in nap-of-the-earth (NOE) flying techniques. That the NOE techniques or future evolutions thereof affect the vulnerability of both aircraft equally and that only the target characteristics of each helicopter are factors for comparison analysis.

4. The mid-intensity environment of extensive exposure to enemy

weaponry is equally applicable to both aircraft throughout the mission profile and that their respective vulnerability is dependent upon their individual key measures of combat effectiveness.

5. Only the TOW weapons systems comparison analysis is necessary for this thesis and it is limited to the number of TOW missiles carried by each aircraft. It is further assumed that any special gunnery training for the TOW missile system is equivalent for both ATH's.

6. Only the current AH-1Q will be used for comparative analysis; consequently, the single AH-1S test platform being developed for qualification testing under the Improved Cobra Agility and Maneuverability (ICAM) contract is not applicable to this thesis. (E1:1-4)

7. Any and all intelligence aspects are equally applicable to both weapons systems. Consequently an in-depth analysis of them is not required for this paper.

8. The command and control aspects except for the onboard radios-communications ability are beyond the scope of this study and will not be used for analysis.

Definitions of Terms

The majority of terms used throughout this study will be standardized Department of Defense and Department of the Army Terms. Any deviations therefrom or conceptual terms used will be explained at their point of use and included in the glossary APPENDIX M.

PURPOSE OF THE STUDY

The purpose of this study is to determine which aviation platform is the better antitank weapons system, the AH-1Q or the OH-58Q.

QUESTIONS TO BE ANSWERED

Legitimate answers to the following questions are required in order to logically answer the thesis problem statement:

1. Characteristics: What key measures of effectiveness or elements can be used to compare the relative effectiveness of each aircraft?

2. Economic Analysis: What are the respective helicopters current acquisition costs? What are the training costs for flight crews and maintenance personnel? What are the logistical support costs? What are the extrapolated kill ratios and costs derived from the Ansbach study?

HYPOTHESIS STATEMENT

If combat effectiveness and economic considerations are of paramount importance in the ATH weapons system, then modification of existing OH-58A's to OH-58Q's would provide the better antitank weapons system.

Chapter II

REVIEW OF RELATED LITERATURE
(DEVELOPING ELEMENTS OF COMPARISON/KEY MEASURES OF EFFECTIVENESS)

The five functions of land combat provide an elementary framework for developing elements of comparison. They are intelligence; mobility; firepower; command, control and communication; and service support. (B12:1-7 and 1-8) As stated earlier, it is assumed that the available intelligence information applies equally to both weapons systems and that excluding communications, the command and control aspects are beyond the scope of this study. By a process of logical elimination, the classical functions which remain for analysis are mobility, firepower, communications and service support. These criteria are supported by other research which states that "The weapon performance variables are a direct result of the weapon design and are classified as mobility, detection, firepower and protection available." (B78:12-14)

COMBAT EFFECTIVENESS CONSIDERATIONS

The combat effectiveness elements of comparison which will be outlined below and further evaluated to determine which are the key measures of effectiveness are: firepower, mobility, detection (target acquisition), vulnerability, protection and communications.

Firepower

Both ATH alternatives will be equipped with TOW missiles.

TOW payload. Key measures of effectiveness include the number of

missiles each aircraft can normally transport to the active combatant area. As previously cited, the AH-1Q is limited to 2 to 6 TOW's depending upon the weather, altitude and mission. (C15:133/B111:335/C15:133) TABLE 2 showed that our European Allies have planned their ATH's to have a payload of two to six ATGM's. This limited payload does not appear to affect the rate of fire. In the Ansbach Trials, the number of simulated TOW's fired per aircraft, per engagement ranged from Ø to 8 with a mean of 3.4. This number was substantiated by other field tests using the ground and vehicular mounted TOW. These tests were conducted in Germany at Fulda Gap and the North German Plain and on similar terrain in the United States. The expected number of missiles that could "be fired against a target moving at 10 miles per hour as it approaches from 3000 meters" ranged from 2.0 to 4.7 or a mean of 3.4 missiles. (B74:xii) This information tends to support an average payload of 4 ATGM's per ATH.

Other Weapons. Neither ATH alternative will be equipped with weapons other than TOW missiles. Therefore, considerations of whether the ATH should possess weapons in addition to the TOW missiles will not be addressed. The rationale for eliminating other weapons systems follows. One way to partially alleviate the AH-1Q's problem of a "degradation in hover performance and endurance" is to remove the M28A1 armament subsystem. (B108:335) This would save approximately $60,000 and 897-pounds of payload per aircraft. (B13:2-69 thru 2-72) It is mandatory in the case of the OH-58A due to its limited payload. Consequently, the M27E1 armament system, with an average procurement price of $17,579 and a loaded weight of 234-pounds will not be used or evaluated in this study. (B13:2-65 thru 2-67)

Firepower Related Literature. During the actual engagements at Ansbach a TOW missile was fired on an average of every 26.6-seconds. This

rate of fire and its effect upon the ammunition supply available will be discussed later in the paper.

An interesting aspect revealed by analysis of the Ansbach Trials was the TOW's effectiveness of only 63.8-percent hits (kills) and 36.2-percent misses. Only kills and misses were evaluated, see APPENDIX A for details. The TOW was technically designed to achieve a hit probability exceeding 80-percent at ranges up to 3000 meters. (B83:19) The "draft" APPENDIX A to FM 100-5 (Test) states that because the TOW "is not range sensitive" it is "most effective at maximum range" and that "it should be employed between 2000 - 3000 meters" in order to "maximize its capabilities." (D1:A-8) The primary reasons for the 63-percent hits is probably due to the effects of intervisibility, time factors, number of observers and relative velocities of the protagonists which will be addressed in more detail under target acquisition.

Another key measure of combat effectiveness under firepower would be the weapons density which is partially determined by missile payload and the dispersion of the ATGM's. Dispersion is required to assist in providing width and depth to the battlefield. This density and dispersion is primarily determined by the number of ATH's available and their missile payload. (B79:X)

Other field tests (APPENDIXES G thru I) did use and evaluate the effects of weapons signatures and suppressive fires; but the author could not find an unclassified study which combined the ATH weapons signatures and suppressive fires in one test. Consequently, comparative analyses are based upon extrapolations wherever required.

Mobility

Historically, evaluation of a weapons systems mobility characteristics have been "limiting speed, acceleration capability, obstacle

trafficability, and maximum range." (B79:1-8)

Due to the numerous variables involved and the flexibility of helicopters, other key factors to be evaluated include agility, flight endurance, size and weather and night capability.

Target Acquisition and Engagement

As previously stated, key measures of effectiveness include intervisibility, time factors, number of observers and relative velocities of the protagonists. Among related studies or research reports concerning the same general subject, the following are particularly noteworth:

TETAM Extracts and extrapolations of some of these reports are contained at APPENDIX G. The five purposes of the TETAM evaluations were to determine: (1) the ability of ATW's (antitank weapons) "to engage maneuvering enemy tanks advancing on defensive positions in various types of terrain;" the reaction ability of the enemy to ATW's signatures; the ATW systems hit probabilities by varying the performance parameters of the missile and using previously established hit data; the ATW systems ability "to detect, engage, and hit advancing enemy tanks when subjected to active countermeasures, suppression, adverse weather, and night operations;" and the effectiveness of multiple ATW's versus multiple enemy targets using various tactics, fire control methods and various weapon mixes. (B72:iv) Although these field tests were restricted to ground or vehicular mounted ATGM's, the statistical data and probabilities are considered valid whenever the AT helicopter is firing TOW's at a three-foot hover above the terrain or setting on the ground. For example: the probabilities for randomly detecting an exposed tank are highly dependent upon the number of observers in the weapons crew or in the immediate vicinity of the weapon. (B72:xi-xiii) APPENDIX G reveals that probability of engagement is extremely

sensitive to handoff time and handoff can only be effectively accomplished by observers in the immediate vicinity of the weapon system.

The Terrain of Western Europe as the Basis of an Antitank Defense Conception. (B85:X) This is an outstanding source document from West Germany which deals with the terrain in depth. It covers such subjects as observation distances; effects of battle conditions and weather upon intervisibility; rate of fire and hit probabilities; and the necessity for a balanced, combined arms antitank defense.

Suitability of the AH-1G Under Arctic Winter Conditions. (B47:X) This study discusses an interesting phenomonen which might affect the intervisibility on the winter battlefield:

> The report states that on four separate days, during gun runs in temperatures between +3°F and -20°F, the formation of fog occurred over the target area. On one occasion after repeated gun runs, an area approximately four by five miles was obscured by fog up to 1,100 feet above sea level. (B47:9)

Attack Helicopter - Clear Night Defense/-Daylight Defense/-Day-Light Offense. These and other field studies conducted by the U.S. Army Combat Developments Experimentation Command (CDEC) were largely on the periphery of the thesis topic; but they did provide some conceptual ideas for comparative analysis and a limited amount of hard data. (APPENDIX H)

The majority of the key measures of effectiveness under "Target Acquisition and Engagement "generally apply equally to any ATH. However, the number of observers and the velocities of the different types of aircraft might tend to favor one alternative over another.

Vulnerability

The increased lethality, sophistication and employment of air defense and ATW's and the proliferation of these weapons on the mid-intensity battlefield was amply demonstrated in the Middle East October 1973, "Yom Kippur War." The U.S. Army and Air Force have attempted to address

the problem of aircraft survivability with computer models and with special studies by civilian corporations. APPENDIX F is a concise listing of the multitude of variables required to develop a computer model which would provide real world probabilities instead of predicting rather finite possibilities based on limited parameters. The special studies tended to be extremely narrow in scope. They dealt with such topics as developmental worthiness and egress systems and the tradeoffs or cost analyses of fully armored helicopters within the current state of the art. (B2:X) Other "vulnerability" related literature is reviewed below.

Aircraft Survivability Equipment (ASE). The U.S. Army Training and Doctrine Command (TRADOC) has designated the U.S. Army Aviation Center as the proponent for the ASE program.

> An Army-wide joint working group...has documented the requirements for survivability equipment in terms of the aircraft, the mission, and the probable current and future threats to be faced...general categories: signature reduction, threat warning, active countermeasures, and vulnerability reduction. (C19:10-11)

Attack Helicopter - Clear Night Defense/-Daylight Defense/-Daylight Offense. These and other field studies conducted by the U.S. Army CDEC were largely on the periphery of the thesis topic; but they did provide some conceptual ideas for comparative analysis and a limited amount of applicable data. (APPENDIX I)

Aural Detection. Two studies dealt with this measure of effectiveness. The Boeing Vertol Company's study was a cross check of a computer model which verified that any helicopter's lower frequency harmonic vibrations were more easily detected; but that the higher frequencies were also a factor. (B1:v) The second was a practical exercise in techniques for a West German air defense unit. The conclusion was: "Although the helicopter advertises its arrival by noise, it is difficult for the

observers to pinpoint the location of the helicopter in the mountains." (B81:5)

Combat Developments aircraft Survivability Methodology is a comprehensive study and is summarized at APPENDIX H. (D3:X) It provides an extensive list of items impacting upon combat effectiveness. Particularly pertinent were concepts regarding the aircraft's visibility as a target presentation and its intervisibility with the enemy's weapons. Target presentation aspects which may be key measures of effectiveness include: radar cross-section; visual silhouette consisting of profile, front, rear, above and below; infrared emissions, electro-optic reflectivity and noise. (D3:3-7)

Helicopter Exposure and Engagement Times...(B87:X) Although this study used a laser semiactive fire and forget missile (Hornet), the results tend to corrobarate other studies and provided time factor charts and graphs which can be easily extrapolated and adapted to the TOW equipped ATH.

TETAM. Another key measure of combat effectiveness is the smoke, dust, or flash that constitutes the visual launch signature of a firing weapon. If the weapon is not fired, then the enemy must conduct a random search of possible weapon positions or location with whatever means he has available. (B72:x-xie) Statistical data and information regarding this aspect of vulnerability is contained in APPENDIX J.

Threat Weapons. Tests conducted within the last two years have concluded that the "concept of attack helicopters operating in a mid-intensity environment is viable." (B90:6)

There are several unclassified sources including texts at the U.S. Army Command and General Staff College (CGSC) and the Armor School. (B73:X/D4:X) Recent guest speakers at CGSC have talked about the mid-intensity

environment and the formidable "air defense umbrella" which the threat possesses. Colonel C. E. Canedy, commander of the Air Cavalry Combat Brigade (ACCB) at Fort Hood, Texas, respects the threat. However, he is quite firm in his belief that proper training and the correct use of terrain flying which is a combination of "low and slow" nap-of-the-earth (NOE), contour and low level flight will effectively counter or neutralize the majority of the threat weapons. The one possible exception is the ZSU-23-SP-4, quad-23mm AAA gun system. (F2:X) This weapons system is deployed well forward and could conceivably affect the battle just forward of or into the main battle area. It has a terrain penetrating radar which is not effected by ground clutter and has a range of 3000-meters with radar and 2500-meters without radar. (B77:15-51/D4:18/F2:X) Based on these tests and the expert testimony, the ZSU-23-SP-4 will be the primary threat weapon used for a comparative analysis of the target presentation aspects of each type of ATH.

Weather Hazards. Due to the fact that both the current and the proposed alternative ATH's are not qualified for flying under instrument flight regulation (IFR) conditions, this vulnerability will not be used as a key measure.

The majority of vulnerability considerations apply equally to both aircraft. The key measure which will be retained for comparison purposes is all the aspects of target presentation. However, it would appear that the most logical answer on the subject was made to Congress by former Secretary of the Army, Stanley R. Resor: "No test short of actual combat can give the final answer on survivability." (B103:666)

Protection

Webster's New World Dictionary define protect as "to shield from

injury, danger, or loss; guard; defend," and protection as "a protecting or being protected." (A8:1142) Essentially, protection incorporates all measures taken to counter, neutralize or reduce the effect of the enemy upon the ATH. For organizational purposes, protection has been arbitrarily listed for discussion as active, passive and miscellaneous measures.

Active measures include firepower using the TOW missile system at 2000 to 3000-meters; mobility aspects which include terrain flying, agility, and vertical movement; size which effects evasive tactics, turning radius, starting and stopping; flight endurance; inclement weather and night capabilities; target acquisition and engagement; and threat warning and active countermeasures such as infrared and radar jammers and decoy chaff/flare dispensers. (C19:11)

Passive measures include crash worthy aircraft systems; armor for key aircraft components and the crew; camouflage and concealment to include signature reduction of the target presentation aspects; light, noise and communications-electronics discipline; dispersion and frequent movement. (D1:A-21/C19:11)

> A weapon can achieve protection by having a small compact profile which blends with the terrain providing an enemy firer a limited or nonexistent uncovered silhouette. A crew-served unarmored weapon provides little, if any, protection to its crew; therefore, terrain is the only available protection for an unarmored weapon. (B79:P12-17)

Miscellaneous measures include training in the use of active and passive measures and extensive use of combined arms tactics with suppressive fires, intelligence and electronic warfare (EW) counter (ECM) and counter-counter measures (ECCM).

The majority of elements related to "protection" are equally applicable to both ATH's and have been addressed under other measures of effectiveness. Many of the hardware items required for better protection are

not currently installed and a satisfactory "survivability package" is not anticipated for several years. (C19:11) The crashworthiness and armor characteristics of each system will be retained for comparative analysis.

Communications

The standard communications installed on each type of AT helicopter (radio transmitters and receivers) will be evaluated to determine if one system is better than the other.

LOGISTICAL CONSIDERATIONS

The key measures of effectiveness are considered to be the acquisition costs of the helicopters with the TOW weapons system and the operating costs per flying hour with details on petroleum, oil and lubricants (POL). Other key measures to be evaluated are the mission availability of each type of ATH based on maintenance factors and deployability characteristics. There are also some general logistical considerations which are significant enough to be mentioned, even though they are not easily quantified.

General Logistical Considerations

The analysis of the Ansbach Trials revealed that a TOW missile was fired every 26.6 seconds. This average was computed from the first shot to the last shot fired by either protagonist during each engagement and does not include enroute or loiter times. This rate of fire is significant and corroberates findings from the 11th Air Assault tests in 1964 and the experences in the Republic of Vietnam.

> As a rule aerial weapons were employed in general support throughout the exercise. One thing that came to light was that fire support planners had to consider the increased logistical requirements of aerial weapons systems. Procedures to control the volume of fire had to be developed...(B78:8-42)

The impact of a rapid rate of fire upon ammumition resupply is significant;

but it is considered to impact equally upon both systems.

Colonel John T. Burke (retired) wrote an article based upon his growing concern with inflation and the world's diminishing natural resources. His analysis of the impact of these factors upon readiness resulted in several recommendations concerning weapons systems acquisition in the future.

> Given a choice between simple and complicated systems, choose simplicity if the comparison is even close. This obviously means greater ease of operation and maintenance. More important here, the simple system is cheaper and easier to produce. It also requires fewer components and fewer materials to make them, so there is less probability of a production stoppage when any one material is not available. (C13:11)

As part of his serious questioning in "Helicopters--Panacea or Pipedream?" published in "The Army Quarterly and Defence Journal," July 1973, Captain R. J. Cohen of the Canadian Land Forces expressed particular concern about logistical support.

> The attack helicopter will be an incredibly sophisticated and complex machine. A viable anti-tank weapons system would require these aircraft in relatively large numbers. Such a force, combined with large numbers of transport and heavy lift helicopters of the air-mobile formations, would create unprecedented demands on the supply system for fuel, ammunition and repair parts. A sophisticated and widely dispersed maintenance organization would be required. That such a system could continue to function in an unfavorable air environment is very doubtful. (B78:8-14)

These general viewpoints are difficult to quantify in a thesis of this scope. Except for the aforementioned key measures of effectiveness, the remainder of these prespectives are considered to be equally applicable to both systems. The rationale for this judgement is that the higher costs for the larger, more complex AH-1Q are generally offset by the larger numbers of the smaller, simpler OH-58Q.

Acquisition Costs

In actuality, there is not a firm or established price for the helicopter mounted TOW missile system. For example, the author has been repeatedly informed in past assignments that the AH-1Q's total and complete

package price is somewhere between $750,000 to $1-million. Other costs associated with the ATH TOW-missile system include a $24.7-million contract to integrate eight (at $3,087,500 each) TOW missile systems into modified AH-1G's. (A7:263) In FY 74, $73-million was provided to modify 101 AH-1G Cobra helicopters which is a cost of $722,772 each. (B108:108) It is assumed that these wide cost differences are attributable to the high costs associated with the initial procurement of new equipment or systems and that the eventual cost for larger numbers will be significantly less.

Due to the fact that it is currently a nonstandard item and to a degree still developmental, some extrapolation was necessary in preparing TABLE 6. For example, the basic costs of the aircraft and the TOW missiles are direct extracts from the SB 700-20. The cost for the M65 Q Provision was derived by comparing the basic costs of the AH-1Q and the AH-1G and assuming that the difference was the M65's cost. The launchers and pylons were an extrapolation of a variety of launchers. The total cost of the ATH TOW missile system was then compared (asterisked items) with the "$225,000 (estimated)" cost of the Standard A, XM26, 6-TOW missile system designed for the UH-1 B/C to determine if it was a reasonably realistic (estimated) figure. (B13:2-90)

TABLE 6

Cost Comparisons AH-1Q:OH-58Q

ITEM	AH-1Q	OH-58Q
BASIC COST	$509,833	$140,624
M65 Q Provision*	15,167	15,167
	525,000	155,791
4 TOW Launchers 2 Pylons*	150,000	150,000
4 TOW Missiles *	12,676	12,676
Q MODEL TOTAL	$687,676	$318,467

$687,676 (AH-1Q) - $318,467 (OH-58Q) = 2.2 = 2

NOTE: As previously stated, there does not appear to be any necessity for additional or special modification costs for the M65 Q Provision for the OH-58Q.

(B14:2-113 thru 2-128)

TABLE 6 clearly shows that a package of two OH-58Q's could be purchased for the same cost as one AH-1Q which is an economically viable alternative. The .2 difference of $50,742 could be used to fund other programs or portions of additional OH packages. The costs associated with both systems will be analyzed in more detail later.

The effectiveness of both systems will be compared using the key measures of operating costs per flight hour and deployability.

PERSONNEL CONSIDERATIONS

Characteristics to be compared and evaluated for each type of aircraft are the training aspects which include length of courses and estimated costs for both aviators and maintenance personnel and the operational aspects such numbers of aviators, maintenance and overhead personnel required for each ATH. The personnel costs are even higher now; but it is interesting to note that research conducted in 1969 revealed that the costs of pilot training ranged from $38,000 to $194,000 with an average cost to the U.S. Army of $90,000 per aviator. (D2:4,20)

Chapter III

COMPARATIVE ANALYSIS

The methodology used is to compare each antitank helicopter (ATH) and then to determine which aviation platform is the better antitank weapons alternative, the AH-1Q or the OH-58Q. The key measures of effectiveness selected for comparison are the combat, logistical and personnel aspects of each system. Based on acquisition costs, initial comparisons will be made on the one AH-1Q:two OH-58Q's ratio.

COMBAT EFFECTIVENESS

The key measures to be compared under combat effectiveness are: firepower, mobility, target acquisition, vulnerability, protection and communications.

Firepower

Due to the AH-1Q's weight to power ratio and degraded performance at maximum weight, it is primarily being evaluated in its weight constrained configuration which requires removal of the M28A1 weapons system and a payload limit of 4-TOW missiles. However, if weather conditions were favorable, it could conceivably carry up to 6 or possibly even 8 TOW missiles dependent upon weather and altitude in the European environment. (B43:108) Due to its limited payload, the OH-58Q is restricted to a maximum of 4-TOW missiles in order to remain within its maximum gross weight limitations.

The Ansbach Trials, the TETAM evaluation results and the European Allies ATH's tend to support a mission load of 4-TOW missiles per aircraft as a good average number. However, during the actual engagements at Ansbach,

a TOW missile was fired every 26.6 seconds. This rate of fire would suggest that in an engagement against a large armored or mechanized force, the ATH should carry as many missiles as its payload allowed. TABLE 7 provides a comparison between the two systems. It is assumed that temperature or density altitude would effect the payload of both ATH's in a similar manner.

TABLE 7

AH-1Q:2 OH-58Q Package
Potential Tank Killing Capabilities

AIRCRAFT	NUMBER OF TOW's PER AIRCRAFT				REMARKS
	2	4	6	8*	*AH-1Q only
AH-1Q	2	4	6	8	
2 OH-58Q	4	8	8	8	same # TOW's as AH
% better	100%	100%	33%	=	OH's avg superiority: 58%

TABLE 7 further reveals that the OH-58Q package is superior to the AH-1Q by a range of 0% to 100% more effectiveness under the same climatic conditions. The average firepower superiority of 58% indicates that the OH-58Q's would provide greater weapons density and potential dispersion on the battlefield than the dollar equivalent AH-1Q.

Mobility

The mobility key measures of effectiveness which may differ are agility or maneuverability which is dependent upon the ATH's size and ability to move in all directions; range or flight endurance which affects time on station; and ability to operate at night or under inclement weather conditions.

In order to conduct its mission on the mid-intensity battlefield, the ATH is going to have to make maximum use of the terrain. One purpose

of mobility can be expressed as the necessity to get into position to fire first.

> For example, in small-unit tank engagements (historically notorious for being independent of force ratios or equipment characteristics), the large range of tactical advantages accruing to the side that is in a position to fire the first round is dominant. (C21:P12-7)

The current methodology of properly using the terrain is referred to as <u>terrain flying</u> which involves a combination of nap-of-the-earth (NOE) flight at a three-foot skid height above the ground under the wires, between the trees and behind the bushes; making maximum use of the folds of the ground, background foliage, stealth and cunning at variable speeds and variable altitudes; <u>contour flight</u> using a steady speed and variable altitudes whicle maintaining a fixed height such as 50-feet over all obstacles; and <u>low level flight</u> which involves using a set speed and altitude determined by the height required to clear the highest obstacle along the proposed flight route.

<u>Agility</u>. Agility is partially determined by the size of the ATH which will frequently be the determining factor of what manner of terrain flight and what terrain can be used during any given mission. TABLE 4 provided relative size information. TABLE 8 extracts this information and FIGURES 1 and 2 (pp.51,52) provide a visual reference of this data.

TABLE 8

AH-1Q:OH-58Q Average Size Comparisons (%)

	AH-1Q	OH-58A
Rotor Diameters	29.5% larger	--
Length, Height & Width	17.5% larger	--
Rotor Areas	50.5% larger	--
Weights	66.5% larger	--

NOTE: TABLE 4 extrapolated. Figures 1 and 2 provide a visual portrayal of the two aircraft for comparative purposes.

These charts show that the AH-1Q is roughly 18% to 51% larger than the OH-58Q in its major dimensions of length, width and height. One way to interpret TABLE 8 is to visualize that compared with the OH-58Q, the AH-1Q is potentially unable to fly or pass between 20% of the trees because of its rotor diameter, under 35% of the taller trees because of its height and a large tail rotor (diameter) which is set quite high; it cannot land or hover close to the ground in potentially 29% of the areas that the OH-58Q can. Conversely, if the main rotor can clear the obstacles height, the AH-1Q could pass its width through 24% more narrow openings than the OH-58Q can. Mathematically, the OH-58Q can use up to roughly 30% more firing positions than the AH-1Q because of its relatively smaller size and its smaller turning radius. TABLE 9 provides a comparison of other agility factors between the two systems. Due to the paucity of unclassified performance data on the AH-1Q's weight constrained version (7900 pounds), both aircraft are compared at their maximum gross weights. The only area that might differ (up to 17%) from the Table 9 data is the maximum climb information expressed in feet per minute (FPM) and miles per hour (MPH). Comparing the two systems results in the analysis that the AH-1Q has a significant advantage in forward speed (37% better than the OH-58Q); however, this is offset by the OH-58Q's better performances than the AH-1Q by 45% in rates of climb, 52 % in maximum hovering abilities and in sideward movement which exceeds 14% because the AH-1Q becomes uncontrollable when moving sideways to the right above 23 mph.

Range. Both systems are generally equivalent in their ranges, total mission time and time on station capabilities.

Weather. Both are generally equivalent in their night and inclement weather capabilities with the AH-1Q possessing a slight advantage in the latter because of its extra navigational aids and flight instruments.

It should be noted that the AH-1Q is not IFR qualified and that instrument flight is "prohibited except when warranted by the tactical situation." (B16:10-1) The OH-58Q is prohibited from flight in falling or blowing snow and is "Instrument Flight Prohibited" without any further qualification or exceptions being listed. (B17:7-4,10-1)

TABLE 9

AH-1Q:OH-58Q
Agility Factors Comparisons

ITEM	AH-1Q (±%) (9500 pounds)	OH-58Q (±%) (3000 pounds)
Airspeeds: miles per hour (mph)		
Maximum	220 (+59%)	138
Rearward	35	35
Sideward	35 (becomes uncontrollable moving to the right above 23 mph)	40 (+14%)
Max "G" limits:	0 (near or below)	UNK
Max Rates: Standard Day (No wind 59°F)		
FPM Climb @ Sea Level (S/L)	1230	1780 (+45%)
Max Climb in MPH Speed @ S/L	75 (+29%)	58
Svc Ceiling	11,400	18,900 (+66%)
Absolute HIGE	9.900	13,600 (+37%)
Absolute HOGE	UNK	6,000
Combat Range Radius (miles)	80	82
Avg Speed (MPH)	144 (+23%)	117
Total Mission Time (hrs)	1.5 (+02%)	1.45
Weather Capabilities:		
VFR	YES	YES
IFR	NO (limited) +	NO (Prohibited)
Night	YES (limited)	YES (limited)
Turning Radius: feet-inches		
w/main rotor	50-0	41-0 (-22%)
w/o main rotor	45-3	32-2 (-41%)

(A7:260,263/B13:1-22,1-58/B16:2-5,7-4/B17:2-5,7-3)

TOW Weapons System Limitations. The ATH TOW weapons system tends to neutralize any mobility advantage that one aircraft might have over the other one. The gyro stabilized optical sight, "2 and 12 power, with 30° and 5° fields of view" respectively replaces the turret sighting station and is mounted in the gunner's compartment. It has roughly the same azimuth traverse, variable elevation and depression as the sight it replaced. The pilots helmet sight is limited by the TOW missile itself and not the pilots ability to rotate his head. Flight profile restrictions must be imposed on the evasive tactics that the ATH may employ "with regard to permissable rates and angles of turn, dive and climb." This is because of the aforementioned sight limitations and "possible control wire vulnerability." Consequently, only two ATH TOW employment techniques are generally used which are based on the target and terrain characteristics. Hovering fire is commonly used when the terrain affords good cover and concealment. After sneaking to within maximum effective range, the ATH pops up and engages the target while at a hover; upon missile impact, the ATH immediately remasks. Running fire is delivered while flying forward. The ATH uses terrain flying techniques until within the maximum effective range, pops up while continuing forward and engages the target. Upon missile launch, the ATH breaks slightly left or right and upon missile impact returns to NOE flight. (B16:6-18 thru 6-36/B62:0-3,0-4)

Mobility Summary. Both systems are generally equivalent with the AH-1Q possessing a significant advantage in forward speed and a limited advantage in inclement weather operations. The OH-58Q possesses significant advantages in potential terrain utilization because of its relatively smaller size; in its rates of climb, maximum hovering abilities and in sideward movements. The limitations of the ATH TOW weapons system further

tend to equalize any relative advantages that one aircraft has over the other one.

Target Acquisition and Engagement

The target acquisition characteristics selected for systems comparisons are the number of observers and relative velocities. Both aircraft are manned by two personnel, a pilot and a copilot/gunner. Consequently, based on the 1 AH-1Q:2 OH-58Q package, the OH-58Q is considered to have a slight advantage over the AH-1Q. For relative velocities, see the above listed "Mobility" discussion. The AH-1Q would probably have a slight advantage over the OH-58Q when using "running fire" techniques against a target at maximum range. However, the AH-1Q's relative speed advantage would generally give the OH-58Q the advantage at the closer ranges due to the TOW weapons systems limitations cited above. Therefore, the relative velocities of the two systems are considered to be generally equivalent.

The OH-58Q is considered to have a slight advantage in the target acquisition and engagement effectiveness due to the larger numbers of observers.

Vulnerability

The majority of vulnerability considerations affect both systems equally. Consequently, the key measure used for comparison purposes will be all aspects of target presentation consisting of radar cross-section; visual silhouette: profiles- front, rear, above and below; infrared emissions; noise; and electro-optic reflectivity. After a general discussion, each of these elements will be discussed individually with primary emphasis being the comparison of each aircrafts vulnerability to the threat's ZSU-23-SP-4 (ZSU 23-4) quad-23mm AAA gun weapons system.

General. The field tests, experiments and exercises researched

tend to provide conflicting evidence regarding which ATH alternative is the easiest to detect, to engage and to destroy. The one area of consensus from virtually all of the studies was that rotor flicker and canopy glint, particularly in the sunlight; movement, color contrast and the shape of the helicopter all contributed to detection. Tested countermeasures included infrared suppressant paint (somewhat effective), and terrain flying (very effective). Other suggested countermeasures which are under study include camouflage paint (for both inflight and ground purposes) and non-light reflective aircraft surfaces, rotors and canopies. Both basic aircraft were specifically mentioned in four studies involving visual detection. In one, the OH-58 was considered the most difficult to detect and the AH-1 was the easiest. However, the conclusions were that detection was not a function of size; but highly dependent upon sun reflectivity. (B61:viii) The extensive and comprehensive CDEC experiments tended to counter this first study's conclusion with the finding that the effect of canopy glint made the OH-58 easier to detect against the terrain; but that there was no apparent difference in either aircraft's detectability against a sky background. The CDEC, in the same experiment concluded that although there was no significant difference between the AH-1's detectability in subsequent pop up maneuvers in, near and against the terrain; that the OH-58's detectability was significantly less on the second and subsequent pop ups.

Visual silhouettes of both aircraft which are roughly-to-scale of the side, top, front views and tail rotor are provided at Figures 1 and 2. The AH-1 and OH-58 size and weight characteristics are also provided to the left of Figure 1 (TABLE 4 repeated) for further comparisons.

TABLE 4

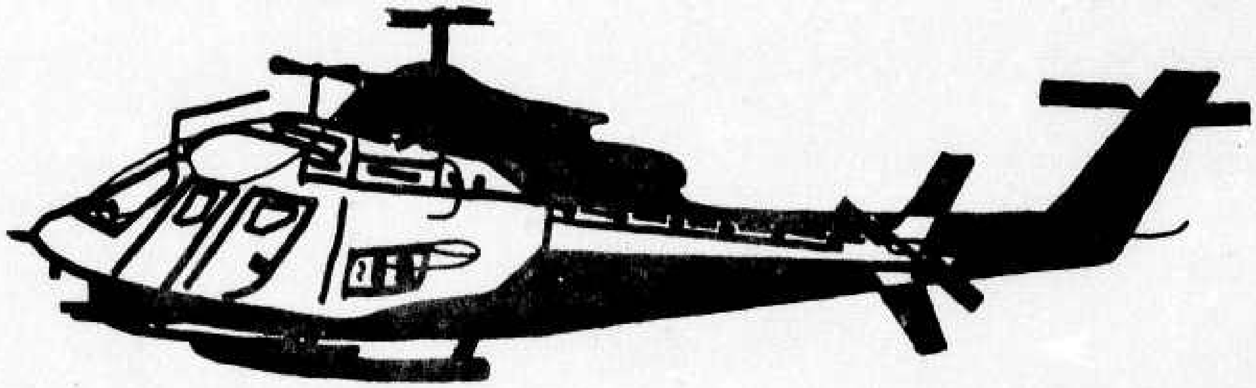
Helicopter Size and Weight Comparisons
(Percentage Differences Between the AH-1Q and OH-58A)

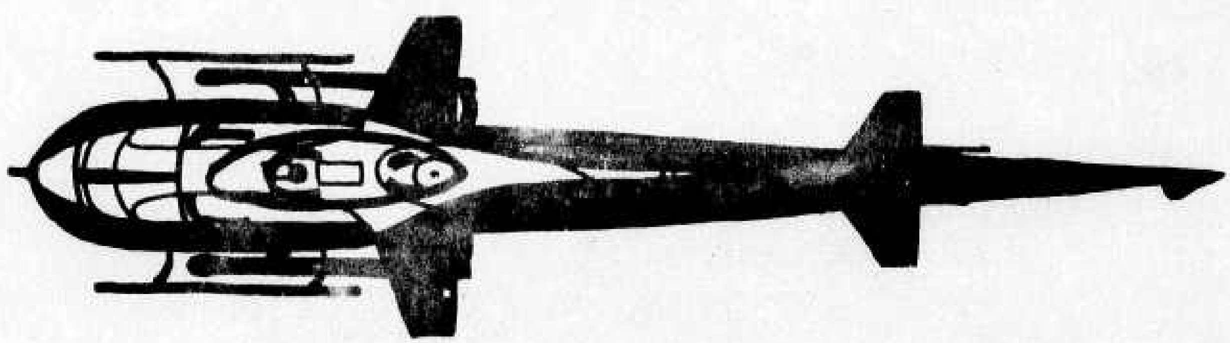
	(A) AH-1Q	(±%)	(B) OH-58A	(±%)	UH-1H (c)
A. DIMENSIONS: (feet:inches)					
1. Diameter of main rotor	44-0	(+20%)	35-4	-	48-0
2. Diameter of tail rotor	8-6	(+39%)	5-2	-	8-6
3. Length of fuselage	45-2	(+29%)	32-2	-	41-10 3/4
4. Overall height	13-9½	(+30%)	9-7	-	14-6
5. Maximum (Max) cabin width	3-2	-	4-2	(+24%)	8-7
B. AREAS: (square feet)					
1. Main rotor disc	1,520.4	(+36%)	978.8	-	1,809
2. Tail rotor disc	56.8	(+65%)	19.7	-	56.7
C. WEIGHTS: (pounds)					
1. Operating weight	6,630	(+65%)	2,313	-	5,557
2. Mission weight	9,734	(N/A)	VARIES	(N/A)	9,039
3. Max T-O & landing	9,500	(+68%)	3,000	-	9,500

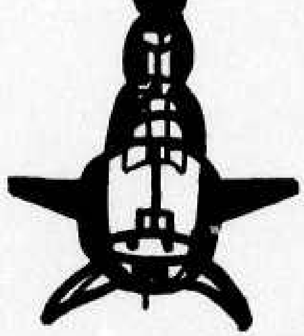
FOOTNOTES ALL: (A7:259-264)
(A): (B13:1-18 thru 1-24/B16:X/F3:X)
(B): (B13:1-55 thru 1-58/B17:X)
(C): (B13:1-69 thru 1-78)

FIGURE 1 OH-58 51

FIGURE 2 AH-1 52







TAIL ROTOR

TAIL ROTOR

Radar Cross-section. A radar cross-section is the specific type of signal indication or radar image reflected by an object which has reflected energy transmitted by a primary radar. This image is primarily determined by the shape, size and weight or mass of the object. The radar mode of the ZSU 23-4 has a maximum effective range of 3000-meters. (B77:15-51/D4:18/F2:x) The OH-58Q is considered to be less vulnerable to this threat than the AH-1Q because of it relatively smaller size and weight.

Visual Silhouette. Based on each aircraft's size and weight characteristics, Figures 1 and 2 and basic logic, it would appear that the OH-58Q possesses a significant advantage over the AH-1Q in this vulnerability characteristic. This advantage is not diminished by the OH's one-foot wider, cabin front profile due to the significant height difference presented by the AH-1Q. However, the aforementioned field tests leave some doubt as to which aircraft is the more easily detected. The dust signature of a helicopter hovering in ground effect is directly related to its size and weight. Consequently, the OH-58Q is considered to have an advantage over the AH-1Q in this characteristic. The visual mode of the ZSU 23-4 has a maximum effective range of 2500-meters. (B77:15-51/D3:18/F2:x)

Infrared (IR) Emissions. The unclassified descriptions of the ZSU 23-4 do not state whether it has this target acquisition capability or not. However, the threat forces do have the capability at the battalion level of visually acquiring a target and engaging it with the SA-7 Strella or Grail IR tracking missile which has a range of 3500-meters. (B78:15-55/D1:A-20, A-22) Although it is not considered to constitute a significant threat based on expert testimony and information from the Ansbach Trials, it is a consideration which can be used for comparative purposes. (B78:8-50/F2:X) The engine data and infrared heat source information follows.

TABLE 10

Engine Comparisons

ITEM	AH-1 Lycoming T53-L-13	(±%)	OH-58 Allison T63-A-700	(±%)
Dimensions: (inches)				
Length	47.6	(+16%)	41.0	
Width	23.0	(+48%)	15.5	
Weight: (pounds)	539	(less tailpipe)	135.0	(-299%)
Shaft Horsepower				
Normal	1250	(+363%)	270	
Military (30 min)	1400	(+342%)	317 (5 min)	
Mean Exhaust Temperature C°				
(Continuous Operation)	513°			
(@/Mil Power 30 min) C°	635°	(-14%)	721°	

(A7:698-702/B13:1-21,1-57)

Extrapolating the information in TABLE 10 regarding the temperature and size of the heat source results in the evaluation that the OH-58Q is less vulnerable than the AH-1Q to the SA-7 Grail or Strella. This IR analysis tends to be analogously supported by an April 1975 magazine article which discusses several cases of multiple missiles being fired at scout and gunship teams in which only the gunships actually received hits. (C26:30-33, 44-45)

Noise. CDEC conducted experiments which directly compared the noise levels of the two aircraft.

> The total loudness of the OH-58 was 50 sones, the AH-1G was 130 sones ...In a subjective observation, by the testers it was noted that the AH-1G was loudest just prior to passing overhead...the OH-58... (was) loudest immediately after passing overhead. (B62:1-25)

NOTE: "Sone" is an international standard representative value of sound (e.g., 1=quiet room, 4=low conversation, 16=orator, 64=truck, 256=jet aircraft, 1024=threshold of pain). All tests were conducted by the aircraft

flying at approximately 115 mph at an altitude of 50-feet above the recording equipment. (B62:1-23 thru 1-28) Based on this sub-test, the OH-58Q is considered to be less vulnerable than the AH-1Q to being detected by noise. If there had been more trials by CDEC or corroboration by other field tests, the OH-58Q would have been considered to have a relatively significant advantage over the AH-1Q due to the former's noise level being loudest "AFTER passing overhead" vice the AH-1Q's "JUST PRIOR to passing overhead" (emphasis supplied by the author).

Electro-optic Reflectivity. Both aircraft are vulnerable to acquisition by active or passive "starlight" night visual acquisition types of equipment. However, the OH-58Q is considered to be less vulnerable due to its lower vulnerabilities in virtually all of the areas previously discussed. Therefore, the OH-58Q is considered to have a slight to significant advantage over the AH-1Q in this measure of effectiveness.

Vulnerability Summary. The OH-58Q is considered to be less vulnerable than the AH-1Q in all of the "target presentation" aspects primarily because of its smaller size, weight and mass.

Protection

Both aircraft provide protection for the crew with armor panels on the seats bottom, back and outboard sides. Additional armor is installed on both sides of the engine compressor sections. The AH-1Q has additional armor protection for the fuel control. Both aircraft have the crashworthiness features of self sealing fuel cells. The OH-58 has the bottom half protected against .30-caliber while the AH-1Q's fuel cells are divided into thirds for protection against bottom .50-caliber; center .30-caliber; top none. The OH-58Q also has self sealing fuel lines and an oil cell. The AH-1Q has a self sealing fuel crossover line. (B13:2-107 thru

2-109/B16:2-2/B17:2-1) The AH-1Q has a slight disadvantage in that should the aircraft crash or roll onto its left side, the copilot/gunner would be unable to egress rapidly. This lack of a rapid egress system combined with the lack of a viable survivability program is estimated to be responsible for 85-percent of all helicopter deaths. (B16:4-3/B38:7) Additionally, the aforementioned crashworthiness features "are expected to reduce inflight and postcrash fuel fires by 72-percent." (B38:9)

The AH-1Q is considered to have a slight protection advantage due primarily to the bottom of its fuel cell being self sealing against .50-caliber projectiles.

Communications

Both aircraft are normally equipped with a frequency modulated (FM), an ultra-high frequency (UHF) and a very high frequency (VHF) receivers/transmitters, an automatic direction finding (ADF) receiver and a transponder/interrogator friend or foe (IFF) transmitter/receiver. The ADF can be used to receive voice or code signals and the IFF can transmit a variety of codes (no voice). Both of these latter radios can be used to augment the other communications systems. The AH-1Q is considered to have a slight advantage over the OH-58Q because the former has additional navigational radio receivers which can also be used to further augment the communications capabilities. (B16:5-1 thru 5-19/B17:5-1 thru 5-15)

Combat Effectiveness Summary

Based on the analyses conducted in each of the key measures of combat effectiveness, the evaluation favors the OH-58Q in "firepower" where it is roughly 58% better than the AH-1Q; "target acquisition and engagement" where it has a slight advantage over the AH-1Q; and it is considered slightly less "vulnerable" than the AH-1Q. Both aircraft are

considered to be generally equivalent in the "mobility" aspect and the AH-1Q is considered to have a slight advantage over the OH-58Q in the "protection and communications" aspects.

LOGISTICAL EFFECTIVENESS

The key measures of effectiveness are considered to be acquisition costs, operating costs and deployability characteristics.

Acquisition Costs

The acquisition costs for the two systems are: $687,676 for the AH-1Q and 318,467 for the OH-58Q. Based on acquisition costs, 2.2 OH's or a 120% superiority over one AH-1Q could be purchased. The savings realized being used for other projects or to purchase additional OH-58Q packages. See TABLE 6 for full details.

Operating Costs per Flight Hour

Basic data and preliminary calaculations are contained at APPENDIX K. It should be noted that the actual fuel consumption rate (not the dollar figure) reveals that per type aircraft, the AH-1Q is 235% higher than the OH-58Q (97 gph versus 29 gph). Or as Colonel Burke recommended in his aforementioned article "Inflation, Scarcity: Dual Threat to Readiness:" "Always compare alternative systems in terms of weight and energy consumption. Apart from its effect on mobility, weight calls for more materiel and more energy to move it. (C13:11) TABLE 11 reveals that when comparing 1 AH-1Q to 2 OH-58Q's, the OH's cost 13.9% less to operate per hour.

TABLE 11

AH-1Q:2 OH-58Q
Logistical Operating Costs per Flight Hour

COSTS	AH-1Q	2 OH-58Q
Parts	$54.00	$62.00
POL	10.49	6.40
Maintenance M/H	44.25	57.40
Attrition	98.84	56.38
TOTAL	$207.58	$182.18

(APPENDIX K)

Deployablity Characteristics and Costs

The basic data and preliminary calculations are contained in APPENDIX L. The U.S. Marine Corps evaluated the OH-58A. Their findings were that three OH's could be efficiently loaded aboard KC-130 aircraft. Total time for disassembly, loading and reassembly was 11-hours. (B115:A-20,A-21) Using an arbitrary $5 per hour would result in a cost of $55 for all three OH's. This information differs significantly from the U.S. Army's planning documents which show two OH's, 61-hours and an arbitrary cost of $305 as depicted in TABLE 14. In the author's judgement, the Marine tests appear to be more realistic; but their evaluation did not extend to additional aircraft transportation means or to comparisons with the AH-1. Consequently, for relative accuracy in making comparisons, only the Army information will be used. The U.S. Marine Corps evaluation of the OH-58A combined with TABLE 12 reveals that the OH's size gives it a significant advantage over the AH by its capability to be loaded aboard C-130 aircraft, delivered well forward into the battle area,

offloaded and reassembled within three thours and placed into combat. (B 115:A-20) The average advantage in deployability characteristics for the C-141 aircraft favors the OH-58Q by 38%. The AH-1Q possesses an advantage over the OH of 19% for the C-5A and 62% for surface shipmnet. Consequently, this effectiveness measure is relatively equal for both systems. However, due to the significant tactical advantage that the OH-58Q possesses by being transportable in the C-130 aircraft, it is considered to have a slight advantage or superiority over the AH-1Q in deployability.

TABLE 12

AH-1Q:2 OH-58Q
Deployability Characteristics

ITEM	AH-1Q	2 OH-58Q
C-130 Aircraft (# loaded)	NA	(2) (+)
Subtotal	NA	$305 (+)
C-141 Aircraft (# loaded)	(2)	(4)
Subtotal	$695 (+38%)	$430
C-5A Aircraft (# loaded)	(12)	(13)
Subtotal	$345	$410 (+19%)
Ocean Shipment (# loaded)	(24)	(24)
Subtotal	$470	$760 (+62%)

NOTE: The numbers of helicopters that can be loaded aboard the aircraft or ship can be increased by further disassembly. (B13:2-120 thru 2-123) The number of aircraft or ships required to transport the equivalent packages is the same.

(APPENDIX L)

Logistical Effectiveness Summary

The OH-58Q is considered to have superiority over the AH-1Q in "acquisition costs" which approximates 120%. In "operating costs," the OH-58Q is considered to be 13.9% more effective than the AH-1Q. The

summary of the "deployability characteristics" appears on the previous page. Based on this analysis, the OH-58Q is considered to be the better alternative within the "Logistical Effectiveness" aspects of comparison.

PERSONNEL EFFECTIVENESS

The key measures of effectiveness to be evaluated for each type of aircraft are the personnel training and operational costs.

Training Aspects

Both officers and enlisted personnel must successfully complete basic courses prior to undertaking the additional skill qualification courses required for the two systems which are being evaluated. In the case of the officers/warrant officers, this basic training may be accomplished either through the Rotary Wing Aviator course or the shorter Rotary Wing Qualification Course. Similarly, the enlisted personnel must be fully qualified helicopter mechanics or have completed Phase I of the MOS (military occupational skill) 67A10 Course prior to starting the additional skill MOS qualification course. (B11:4-2C-1,-4,-13;5-60-7,-8) These basic entry requirements are considered to be equivalent for both systems.

NOTE: A review of the U.S. Army Formal Schools Catalog, DA Pamphlet 350-10, revealed that a formal course for the AH-1Q is not listed. Therefore, this analysis will be based upon a compariosn of the qualification courses for the AH-1G and the OH-58A.

Officers Training. The AH-1's course is four-weeks-two-and-one-half-days and the OH-58 course is two-weeks-one-and-one-half-days or 31-days for two OH-58Q's. (B11:4-2C-4,-13) Consequently, the AH-1Q possesses a 1.6% superiority over the two OH-58Q's in the officer training aspects in a peacetime environment.

The course lengths do not change during mobilization for either

aircraft. The OH-58Q course can field nearly 97% more qualified aviators than the AH-1Q course can during peacetime or wartime within the same time-frame. This is considered to be a significant tactical advantage during a mid-intensity conflict because of the lethality (see casualty rates) which is anticipated on the modern battlefield. The two OH-58Q transitions cost roughly $17 more than the AH-1Q.

Enlisted training. The AH-1G Helicopter Repair Course is 79.5-days long and the OH-58Q's is 35.5-days in length or 71-days for two. Thus, the two OH's have a 12% advantage over the one AH. The training for one AH exceeds the two OH's personnel costs by approximately $5. This situation would tend to reverse and favor the AH in the larger packages. Similar to the officers traiing, the enlisted training time for the OH would result in 123% more qualified mechanics being placed in the field within the same time frame.

Operational Aspects

The operational aspects are based primarily on the personnel manning requirements for each system.

Officers. The U.S. Army's general criteria for aircraft manning is two pilots for the AH-1G and one pilot for the OH-58A. (B13:3-1) Due to the necessity for terrain flying, the extensive exposure to enemy fire and the responsibilities involved in engaging targets at long ranges, it is anticipated that the OH-58Q would also have to be manned by two pilots. Consequently, the AH-1Q would possess an advantage of 100% in the smaller ratio package. This ratio would become even more significant in the larger packages. Computed on a monthly basis of 30-days, the AH would Cost $2,000 less than the two OH's.

Enlisted. The direct and indirect maintenance personnel required to support both alternatives were discussed under "Logistical Effectiveness."

Personnel Summary

During mobilization, the OH-58Q possesses a distinct advantage due to the shorter lengths of its training courses. The AH-1Q tends to have the superior advantage in all other respects, particularly when contemplating the larger packages of AH's:OH's.

COMPARATIVE ANALYSIS SUMMARY

This chapter has provided additional background information on the various tests and exercises which have proven the viability of the concept and the necessity for fielding an antitank helicopter in the near future. It has also shown that the OH-58Q is a feasible alternative to the current AH-1Q from both perspectives of weight and cost. Based on selected key measures of effectiveness previously identified in Chapter II, a ratio or package of 1 AH: 2 OH was used to develop percentages and costs for relative comparisons, the key measures of effectiveness will be further refined, analyzed and evaluated in the next chapter.

Chapter IV

ANALYSIS AND EVALUATION

Based on the facts and information contained in the unclassified references reviewed in Chapter II, key measures of effectiveness were developed and partially analyzed. In Chapters II and III, these key measures were partially evaluated through the use of direct fact comparisons, analogies and the author's interpretations with rationales provided where necessary. However, due to the inherent noncommonality of many of these key measures; a more definitive comparison is necessary in order to determine which weapons system, the AH-1Q or the OH-58Q is the better anti-tank helicopter (ATH) alternative.

GENERAL

The data already developed will be modified as necessary to provide legitimate, relative comparisons of percentages and/or dollars on a one to one basis. These comparisons will be supplemented with the author's statements based upon the information and references researched. The AH-1Q will be initially analyzed in its 7900 pound weight constrained version which has a mission payload of four TOW's. The OH-58Q will also continue to have a mission payload of four TOW's. Using the data from TABLE 4, the AH-1Q costs \$687,676 compared to \$318,467 for the OH-58Q. Consequently, the OH costs \$369,209 or 116% less per copy than the AH.

COMBAT EFFECTIVENESS

Based on the "combat effectiveness" information previously developed,

the author considered the AH-1Q to have a slight advantage over the OH-58Q in the 'communications' aspect only because of its additional radio navigational aids. The AH-1Q is considered slightly superior in the "protection' aspect solely because of the lower half of its fuel cell being self-sealing against .50-caliber projectiles. Both systems are considered to be generally equivalent in the 'mobility' aspects because of the tradeoffs of speed and agility and the further equalization of the systems due to the inherent limitations of the TOW weapons system itself. Both aircraft on a one to one basis are considered to be equal in 'firepower' because of their limited mission payload of four TOW missiles and the fact that neither ATH has any other weapons systems installed. Since the crew manning for each aircraft is the same, both systems are considered equivalent in the 'target acquisition and target engagement' aspects. The OH-58Q is considered to be slightly less 'vulnerable' than the AH (i.e., superior to the AH) in all target prsentation aspects primarily due to its smaller size, weight and mass.

When considered on a one-to-one basis, both systems are generally equivalent in the key measures of "combat effectiveness."

LOGISTICAL EFFECTIVENESS

The "logistical effectiveness" key measures selected for further analysis are 'operating costs per flight hour' and 'deployability characteristics.'

Operating Costs per Flight Hour

The 'operating costs per flight hour' per aircraft (A/C) was extracted from TABLE 11. Applying these costs by A/C to the U.S. Army standard flying hour program is reflected in the following table. The costs per flight hour were $208 for the AH and $91 for the OH.

TABLE 13

AH-1Q:OH-58Q Operating Costs

ITEM	AH-1Q (±%)	OH-58Q (±%)
Peacetime (hours per A/C)		
Monthly (20)	$ 4,160	$ 1,820
Annually (240)	49,920	21,840 (-129%)
Combat		
Monthly (70)	$ 14,560	$ 6,370
Annually (840)	174,720	76,440 (-129%)

The above table clearly shows that the OH-58Q is roughly 129% less expensive or 129% more efficient to operate per flight hour than the AH-1Q.

Deployability Characteristics and Costs

The 'deployability characteristics and costs' were developed in APPENDIX L and TABLE 12. This information is summarized by type transport A/C and ocean shipment in TABLE 14. The costs depicted are for disassembly, loading/off loading and reassembly.

TABLE 14

AH-1Q:OH-58Q Deployability Characteristics

TRANSPORT COSTS	AH-1Q (±%)	OH-58Q (±%)
C-130 A/C	NA	$153
C-141 A/C	$695	$215 (-223%)
C-5A A/C	$345	$205 (-68%)
Ocean Shipment	$470	$380 (-24%)
AVERAGES (excluding C-130 # loaded Cost	(12) $503	(13) $267 (-88%)

Because of its size, the OH-58Q possesses a distinct tactical advantage over the AH-1Q. The OH-58Q can be delivered by C-130 A/C well forward into the battle area, offloaded, reassembled within three hours and then placed into combat. (B115:A-20)

TABLE 14 clearly shows that more OH-58Q's can be transported by the various types of transportation and that the OH's superiority ranges from 0% to 200%. The OH-58Q also has lower dollar costs which range from 24% to 223%.

PERSONNEL EFFECTIVENESS

The personnel costs for both direct and indirect maintenance man-hours were included in "logistical effectiveness." The personnel costs for training and operations were developed in Chapter III and are summarized in TABLE 15.

TABLE 15

AH-1Q:OH-58Q Personnel Costs

ITEM	AH-1Q Course Length	AH-1Q $ (±%)	OH-58Q Course Length	OH-58Q $ (±%)
Training				
2 Officers (0)	30.5-days	$2034	15.5-days	$1034
Enlisted (one E per 6 A/C = .17)	79.5-days	225	35.5-days	101
Subtotal		$2259		$1135 (-99%)
Operations (2 O's, .17 E)				
Per Year (0)		$24,000		$24,000
Per Year (E)		1,020		1,020
Subtotal		$25,020		$25,020

The OH-58Q training course costs are 99% less than the AH-1Q on a one-to-one basis. The OH-58Q also takes roughly half the time to train the same

number of required personnel. Based on the anticipated losses for a mid-intensity conflict, this training time difference is considered to be another factor which favors the OH-58Q ATH alternative.

BASIC ECONOMIC COMPARISON

Based on the information and the comparisons presented in Chapter IV, the following elementary economic analysis for a one-year period was developed. This table excludes attrition factors, 18% combat losses and the 80% maintenance availability considerations which are considered roughly equivalent for both systems in the one-to-one basis.

TABLE 16

One-Year AH-1Q:OH-58Q Economic Comparison

ITEM	AH-1Q (±%)	OH-58Q (±%)
Acquisition Costs	$687,676	$318,467
One-time Training Costs	2,259	1,135
Avg Deployability Costs	503	267
Combat Flying Hour Costs (840)	174,720	76,440
Personnel Operating Costs	25,020	25,020
	$890,178	$421,329 (-111%)

TABLE 16 clearly shows that the OH-58Q costs roughly $468,849 or 111% less per annum than the AH-1Q.

The one-to-one basis of comparison clearly shows that the OH-58Q is the better ATH alternative from a pure cost perspective. The weakness of this comparison is the relatively remote possibility that the AH-1Q could carry its maximum payload of eight TOW's on a given day. Therefore, another comparison from a cost ratio per annum basis will be used to compare an eight-TOW AH-1Q package to a four-TOW OH-58Q package. This ratio,

developed from a cost perspective viewpoint, will be used to compare one realistic probability along a continuum of package comparison possibilities.

EIGHT-TOW AH-1Q ACQUISITION COSTS AND REVISED RATIO

Using the data developed in TABLE 6, four additional launchers at $25,000 each and four additional missiles at $3169 each equals $112,676 for a total acquisition cost of $800,352 for the eight-TOW AH-1Q. Extrapolating the data from TABLE 16 results in the revised annual cost comparisons of $1,002,854 for the AH-1Q and $421,329 for the OH-58Q which equals a ratio of 1:2.38.

ATH PACKAGE ALTERNATIVES

Using the ratio of 3 AH-1Q:7 OH-58Q, another analysis and evaluation will be conducted to test the key measures of effectiveness of the alternative packages.

Combat Effectiveness

The "combat effectiveness" key measures which are essentially unchanged are 'mobility', 'vulnerability', 'protection' and 'communications'. The remaining measures to be reevaluated are the 'firepower' and 'target acquisition and engagement' aspects.

Firepower. The TOW missiles are the only weapons systems mounted on the ATH's because of weight limitations. Consequently, the maximum possible mission payload of eight TOW's for the AH-1Q (24) and four TOW's for the OH-58Q (28) will be the basis for comparisons. Other factors which effect the packages and will be used for evaluation and analysis are attrition factors (APPENDIX K); 20% not operationally ready, maintenance (NORM) and 18% combat loss rates (APPENDIX A). The basic payloads of

24:28 TOW's for the packages appears to favor the OH by 17%; however TABLE 17 provides a slightly more realistic comparison. Although it is not realistic to have decimal fractions of aircraft or personnel, these fractions will be used for comparison purposes, in order to provide statistically valid results.

TABLE 17

Statistical Attrition, Maintenance and Combat Loss Factors

ITEM	3 AH-1Q (24 TOW)	7 OH-58Q (28 TOW)
Attrition Factors	.0093	.0147
Remaining A/C	2.97	6.89
(Remaining TOW's)	(23.78)	(27.59)
Potential Firepower		16% superiority
20% NORM	.6	1.4
Remaining A/C	2.4	5.6
(Remaining TOW's)	(19.2)	(22.4)
Potential Firepower		17% superiority
18% Combat Losses	.54	1.26
Remaining A/C	2.46	5.74
(Remaining TOW's)	(19.68)	(22.96)
Potential Firepower		17% superiority

NOTE: If the sample were extremely large, such as a ratio of 600 AH: 1400 OH, the superiority trend would remain valid; but the relatively significant percentage differences would tend to decrease slightly.

The basic number of aircraft and remaining aircraft can be viewed as the quantity of weapons systems providing density or dispersion in depth and/or width throughout the battle area. This perspective results in the OH-58Q advantage of 131% to 133% in numbers of aircraft and the 16% to 17% superiority in basic mission payload.

Combining the attrition factors and the combat losses would result in the loss of roughly one aircraft from each package (.5493:1.2747). This

would result in a statistical combat/attrition dollar loss or materiel replacement cost of $439,633:$405,950 respectively. If the statistical pilots for each aircraft are assumed lost, this would result in a statistical replacement training cost of $1117:$1318. The net replacement costs are $440,750 AH:$407,268 OH which favor the OH package by roughly 8%.

Consequently, the author's analysis and evaluation of the 'firepower' aspect of the two packages of 3 AH-1Q:7 OH-58Q is that the OH is the better ATH alternative by roughly 8% to 133%. The other dollar costs developed will be used in the packages economic analysis.

Target Acquisition and Engagement. The 7 OH-58Q's are considered to be about 133% superior to the 3 AH-1Q's due to the 'number of observers'. The OH's 14-pairs of eyes in seven locations versus the 6-pairs of eyes in the AH's three locations would tend to increase the random detection probabilities of the OH's. The significant remaining measure of 'firepower' potential and 'target acquisition and engagement' superiority of the OH-58Q clearly results in the determination that the OH package is the better ATH alternative from a "combat effectiveness measurement."

Logistical Effectiveness

The 'acquisition costs' of the two packages are $2,401,056 for the 3 AH-1Q's and $2,229,269 for the 7 OH-58Q's. This $171,787 difference also tends to favor the OH.

Extrapolating the combat data costs from TABLE 13 results in the 'logistical operating costs' of $524,160 for the 3 AH's and $535,080 for the 7 OH's per annum. It should be remembered that this figure could be misleading in that the documented costs for POL are quite low in comparison to the world situation and that the AH-1Q consumes 68 more gallons or 235%

more JP4 per hour than the OH-58Q does. The ratio of 291:203 gallons per hour reveals that the AH package consumes roughly 43% more POL per hour than the OH package does. This difference could become even more significant if fuel prices continued to rise and/or additional packages were procured. The number of transport aircraft or ships remains equivalent for this ratio package; however, the larger ratios at the upper capacity would tend to favor the AH-1Q package due to the lesser numbers and cubic volume involved. The average transportation costs of $1509:$1869 also tend to favor the 3 AH's in 'deployability characteristics' by roughly 24%.

TABLE 18

3 AH-1Q:7 OH-58Q LOGISTICAL COST COMPARISON

ITEM	3 AH-1Q (±%)	7 OH-58Q (±%)
Acquisition Costs	$2,401,056	$2,229,269
Annual Cbt Log Operating Costs*	524,160	535,080
Avg Deployment Costs	1,509	1,869
TOTAL COSTS	$2,926,725	$2,766,218 (-6%)

*Excludes expended TOW ordnance which is considered roughly equivalent for both systems.

TABLE 18 clearly shows that the OH-58Q package is 6% or $160,507 less expensive. The author's analysis is that the OH-58Q package is the better alternative from a "logistical effectiveness" viewpoint.

Personnel Effectiveness

The personnel costs for both direct and indirect maintenance manhours were included in the "logistical considerations" aspect. The personnel costs for training and operations were developed in Chapter III and summarized in TABLE 15. Extrapolating this data results in TABLE 19.

TABLE 19

3 AH-1Q:7 OH-58Q Personnel Costs

ITEM	3 AH-1Q	($\pm$%)	7 OH-58Q	($\pm$%)
One-time Training				
(#) Officers	(6) $6102		(14) $7238	
(#) Enlisted	(.17) 225		(.34) 201	
Subtotal	$6327	(-18%)	$7439	
Operations per Annum				
(#) Officers	(6) $72,000		(14) $168,000	
(.17) Enlisted	1,020		2,040	
Subtotal	$73,020	(-133%)	$170,040	

The AH package is approximately 18% less expensive for training costs. However, it should be remembered that the OH package personnel can be trained in about one-half the time required for the AH. This is considered to constitute a distinct tactical advantage for the OH in a mid-intensity environment. The AH package is also roughly 133% less expensive per annum for personnel costs. Therefore, the AH is considered to possess an 18% to 133% personnel advantage over the OH in the 3:7 ratio which is offset to some degree by the OH's shorter training time advantage.

PACKAGE ECONOMIC COMPARISONS

Based on the information and comparisons presented to this point, TABLE 20 was developed. This table includes all of the quantifiable dollar information presented in the thesis.

TABLE 20

One-Year 3 AH-1Q:7 OH-58Q Economic Analysis

ITEM	3 AH-1Q (±%)	7 OH-58Q (±%)
Acquisition Costs	$2,401,056	$2.229,269
One-Time Training Costs	6,327	7,439
One-Time, Avg Deployment Costs	1,509	1,869
Combat Flying Hour Costs	524,160	535,080
Combat/Attrition Replacement Costs	440,750	407,268
Personnel Operating Costs	73,020	170,040
PACKAGE ANNUAL COSTS	$3,446,822	$3,350,965 (-3%)

NOTE: The OH package costs 3% or $95,857 less than the AH package per annum. The author considers this a low estimate of the OH superiority due to the POL consumption data previously presented.

3 AH-1Q:7 OH-58Q SUMMARY

The package concept of a ratio of 3 AH-1Q:7 OH-58Q ATH's resulted in the conclusion that the OH package is roughly 17% to 133% superior in 'firepower,' possesses a 133% advantage in the 'target acquisition and engagement' aspects and is less 'vulnerable' in virtually all target presentation aspects. Both systems are considered roughly equivalent in 'mobility'. The AH package is considered to have a slight advantage over the OH's in the 'protection' and 'communications' aspects. These analyses and evaluations were further supported by the OH's capability to be transported in C-130 aircraft and be in combat within three-hours after the C-130 lands in the forward battle area. Another potential tactical advantage results from the OH's short replacement training time which is roughly one-half that of the AH. The author considers the 7 OH-58Q's to be a better ATH alternative than the 3 AH-1Q's based upon the discussion of the key measures of "combat effectiveness". The "logistical effectiveness" measurements also favored the OH package by roughly 6% over the AH package.

The "personnel effectiveness" measurements tended to favor the AH package by 18% to 133%; but this was partially offset by the OH's shorter training course lengths. An elementary economic comparison resulted in the analysis that the 3 AH-1Q package cost roughly 3% more than the 7 OH-58Q package. However, the author believes that the OH package is even more superior than the documented 3% difference of $95,857 per annum indicates:

> ...savings of factors of from three to ten are available in the great majority of tactical weapons systems when emphasis is placed on minimum complexity or achieving a single defined combat mission capability. In all cases, these austere alternatives will achieve greatly improved reliability; in many cases, significantly improved performance and combat effectiveness also will result...If our more complex, newer weapon systems have demonstrated little proven relevance to success in combat, but serious deficiencies in reliability and countermeasures-susceptibility, then larger numbers of simpler, testable systems of demonstrated reliability, with fewer demands on supporting troops, are likely to prove more useful. But, even here, we should be cautious because it is easy to overestimate the value of more forces. (C21:P12-4 and-5)

Based on the comparisons and evaluations of the key measures of effectiveness with the alternative packages, it is the author's considered judgement that the 7 OH-58Q package is the better ATH alternative.

Chapter V

SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this partially experimental and unclassified thesis was to determine which aviation platform would be the better antitank weapons system, the AH-1Q or the proposed OH-58Q.

SYNTHESIS

This problem was introduced by determining that a significant tank threat faces NATO and the U.S. Army in the potential mid-intensity conflict environment of Central Europe. The combination of the Warsaw Pact tank threat; the mid-intensity high materiel consumption rates; inflationary trends; Congressional concerns which include defense budgets and the U.S. Army's problems in Research and Development; the marginal performance of the current AH-1Q TOW-Cobra; the proposed acquisition of only 472 of the relatively large, sophisticated and expensive advanced attack helicopters (AAH's) with a projected delivery date of the mid-1980's reflected the current environment and set the stage for considering another alternative.

The hypothesis statement to be tested and used as a vehicle for this unclassified thesis was: "If combat effectiveness and economic considerations are of paramount importance in the antitank helicopter weapons system, then modification of existing OH-58A's to OH-58Q's would provide the better antiank weapons system."

Key measures of effectiveness were partially developed by reviewing basically two different concepts of the antitank helicopter (ATH). The European concepts with their similar missiles were used to hypothetically

convert the existing OH-58A to an ATH designated the OH-58Q which was then compared with the current AH-1Q.

After a broad development of elements of comparison, a limited discussion and elimination; some key measures of effectiveness and their subtopics were retained for comparison and evaluation. COMBAT EFFECTIVENESS which was determined by the subtopics of "Firepower", "Mobility", "Target Acquisition and Engagement", "Vulnerability", "Protection" and "Communications"; LOGISTICAL CONSIDERATIONS consisted of "Acquisition Costs", "Logistical Operating Costs" and "Deployability Characteristics"; and PERSONNEL CONSIDERATIONS with the subtopics of "Training Costs" and "Personnel Operating Costs" were used for comparative analysis.

After determining that the OH-58Q was feasible from both a cost and weight perspective; each of these topics and subtopics were compared and evaluated on a 1 AH:2 OH ratio based on acquisition costs; a 1 AH:1 OH ratio for direct comparison data and a package ratio of 3 AH-1Q's:7 OH-58Q's to develop statistical data of a relative nature which would be applicable to any multiple of this ratio. An attempt was made to provide legitimate, statistically relative data for future use by force development planners and other researchers.

CONCLUSIONS

The conclusions derived from the data developed in the 1 AH:1 OH and 1 AH:2 OH comparisons to include a brief economic analysis were conclusively in favor of the OH-58Q from a pure cost perspective.

<u>1:1 Ratio</u>

Both of the single aircraft in the 1:1 ratio and their antitank systems were essentially equivalent in the majority of combat effectiveness"

measurements with the OH slightly less vulnerable than the AH in all 'vulnerability' aspects and the AH slightly superior to the OH in the 'protection' and 'communications' aspects.

1:2 Ratio

In the 1 AH:2 OH ratio, "combat effectiveness" measurements tended to favor the OH's by 58% in 'firepower' and by a slight advantage in the 'target acquisition and engagement' aspects. Other "combat effectiveness" measurements remained the same as in the 1:1 ratio. The "logistical effectiveness" also favored the OH-58Q's by roughly 8% in 'acquisition costs', 14% in 'operating costs per flight hour' and by a slight advantage in 'deployability characteristics'. There were not any significant differences in the "personnel effectiveness" measurements for the 1 AH-1Q:2 OH-58Q ratio.

3:7 Ratio

There was a relatively remote possibility that the AH-1Q could carry its maximum payload of eight TOW's on a given day. Consequently, another ratio based upon the annual costs of the single helicopters along the continuum of package possibilities was used for a more definitive analysis. The conclusions derived from this ratio conclusively favored the OH package to an even more significant degree than in the previous ratios. "Combat effectiveness" measurements gave the OH-58Q a range of 17% to 133% superiority over the AH in 'firepower" and 'target acquisition and engagement'. The other "combat" measurements were essentially unchanged from the 1:2 ratio and the "logistical costs" favored the 7 OH-58Q's by 6%. The only area that the 3 AH-1Q's possessed a significant advantage with a range of 17% to 133% over the OH's was in the "personnel costs" measurements. However, the ultimate package costs per annum favored the 7 OH-58Q's by at least 3%.

HYPOTHESIS CONCLUSION

Based on the unclassified research conducted and the data developed for comparative analysis and evaluation, it is the author's conclusion that the OH-58Q is more combat effective and less costly throughout its life cycle. Therefore, OH-58A's should be modified to OH-58Q's to provide the better antitank weapons system alternative.

RECOMMENDATIONS

It is recommended that classified reports of tests and/or exercises and other references be surveyed to determine the full validity of the unclassified information used to test the hypothesis.

Assuming that the hypothesis is still valid after comparison and evaluation with classified studies, it is recommended that the required number of OH-58Q antitank helicopters be determined and that development activities be implemented to supplement or to replace the current AH-1Q solely in its antitank role in the near future.

It is further recommended that concurrent research, development, test and evaluation of a small, simple, cheap and virtually expendable antitank helicopter be implemented to achieve even greater combat effectiveness and significant savings in the spirit of Department of Defense's "hi-lo mix" concept.

Based on the author's unclassified research, it is recommended that additional field tests and exercises be conducted in a larger scale combined arms environment. Particular emphasis should be placed on eliminating the weaknesses of the Ansbach Trials such as the use of suppressive fires and the probable effects of various weapons systems engaging only the exposed main mast and rotor blades of the antitank helicopters.

APPENDIXES

APPENDIX A

Ansbach Trials - General Information

APPENDIX A

Ansbach Trials - General Information
(Extrapolated from Appendixes B-E and C28:X)

The Ansbach Trials constituted a free play exercise conducted during April and May 1972. A variety of typical terrain in Central Europe was used to prevent participants familiarity. The trials were conducted under meteorological conditions which inluded moderate rain, bright sunshine, completely overcast, moderate ground fog, haze and gusty winds. This test is a key measure of the general effectiveness of the antitank helicopter concept.

Range measurement and clocked lasers were used to simulate major weapons systems and to provide "real time" kill ratios. There was no analysis of disabling hits vice kills. All simulated hits were considered kills and near misses were also logged.

The effects of suppressive fires by or upon either side were not played in the exercise. The numerical superiority of the threats tactical air forces and their artillery and heavy mortors (the latter can outrange their U.S. Army counterpart weapons) is considered a significant factor which was not evaluated. (A5:80,91/D1:A-17 thru A-19)

The exercise was conducted in the vacuum of helicopters versus the aggressor's three tanks and one ZSU-23-4. Consequently, the effects of combined operations which would probably have been a significant factor for both protagonists was not evaluated.

Dependent upon the source, the kill ratios derived vary slightly. Brooke Nihart states that the Army anticipates scout losses anyway, so that a 19.6:1 ratio is valid for comparing both tanks and air defense weapons against only Cobras. (C28:8-50)

The small variance between Nihart's final figures and the Ansbach Trials preliminary and unclassified raw data (which has been extrapolated, compiled and statistically evaluated in Appendixes B through E) appears at APPENDIX TABLE 1.

One possible reason for the lower figures in the right hand column is the fact that some helicopters were initially credited with kills after they had theoretically been killed. This illogical data was eliminated by the author during extrapolation.

APPENDIX TABLE 1

Ansbach Trials Summary

Losses and Kill Ratios	SPIRCES	
Equipment	Nihart	Appendix B
AH-1G's killed	10	11
OH-58's killed	4	4
Tanks killed	167	164
Vulcans killed	29	26
Kill Ratios		
Tanks & Vulcans:Cobras	19.60:1	17.30:1
Tanks:Cobras	16.70:1	14.90:1
Tanks:Cobras & Scouts	12.00:1	10.90:1
Tanks & Vulcans:Cobras & Scouts	(14.00:1)	12.70:1
MEAN KILL RATIO	15.58:1	13.95:1

The study has also been criticized for being unrealistic due to a variety of judgemental factors which might be considered to favor one protagonist or another. Extracts of the Joint Evaluation Group's analysis of these factors are contained in APPENDIX TABLE 2.

APPENDIX TABLE 2

Ansbach Trials
Factors Favoring Each Protagonist

<u>Helicopters (varied mix)</u>

1. Always on defense

2. Always fired from a hover (maximum use of terrain, background foliage, stealth and cunning vice toe-to-toe confrontation)

3. Effects of enemy tank coaxial weapons, Redeyes and jets were not available in the preliminary data

NOTE: Advance information on the Redeye suggests very few hits were made. (B78:B-50)

4. Laser sensors were below the rotor system (vulnerability of hits to rotor system and mast is an unanswered question)

AUTHOR'S COMMENTS:
The weapons signature effects for the ATH TOW missile and the threat weapons were not played in the exercise.

<u>3 Tanks/1 ZSU-23-4 (static mix)</u>

1. Retained aggressor size and crews throughout the experiment. Helicopter crews rotated, seldom formed same mix more than once.

2. Supposedly lead platoon of a larger force; but used techniques that were not in threat doctrine.

   a. Consequently, harder to acquire, less exposed and did not have any flank considerations or restrictions.

   b. Helicopters restricted to consider flank platoons and restricted to a maximum 60-degrees fire cone in the direction of the enemy attack and a 90-degrees cone during the enemy breakthrough.

3. Most observers felt that the restrictions on the helicopters resulted in overly conservative tank kills.

4. The ZSU-23-SP-4 could not be killed and continued to fire even when hit, thus there was more air defense than can be expected on the battlefield.

5. The helicopter sight had a much narrower field and less magnification than the standard TOW sight.

(B80:X)

APPENDIX B

CUMULATIVE HIGHLIGHTS OF ALL ANSBACH TRIAL EXERCISES

D.H.

APPENDIX B

CUMULATIVE HIGHLIGHTS OF ALL ANSBACH TRIAL EXERCISES
(Appendixes C-E Extrapolated)

MISSION	TRIALS	AIRCRAFT AH	AIRCRAFT (OH)	TOW FIRED	TOW AVG	AVG MFT	LOSSES AH	LOSSES (OH)	LOSSES KT	LOSSES KA	AVG RANGE
DELAY	20	29	(20)	69	2.4		2	(1)	31	9	
DEFEND	20	30	(20)	67	2.2		3	(1)	41	4	
BREAKTHROUGH	20	29	(20)	162	5.6		6	(2)	92	13	
TOTALS	60	88	(60)	298			11	(4)	164	26	
MEANS					3.4	08.80'					2019

	HITS	MISSES	TOTAL
TOW's Fired	190 (63.8%)	108 (36.2%)	298 (100%)

KILL RATIOS: 1:17.3 (AH's only)

1:12.7 (AH's and OH's)

NOTE: Theoretically, a TOW was fired every 26.6' (seconds) during the engagements.

TOTAL EXERCISE DURATION (ED) was 19 hours. 17 minutes: 42 seconds'. Total time elapsed from first shot fired by either protagonist unitl last shot fired by either protagonist (i.e., other protagonist theoretically destroyed.) ED does not include loiter or movement times.

HEADINGS USED

MISSION- Self explanatory

TRIALS- Number of trials conducted for each type of mission

AIRCRAFT
- AH- Attack Helicopter (AH-1Q), numbers participating
- OH- Observation Helicopter (OH-58A), numbers participating

TOW
- FIRED- Numbers fired
- AVG- Average number fired per AH, per engagement

AVG MFT- Average missile flight time (from launch to impact or miss)

LOSSES- Type and number of each destroyed (killed)
- AH-
- OH-
- KT- tank (simulated T-62)
- KA- Air Defense (AD- simulated ZSU-23-4)

AVG RANGE Average (mean) range from helicopter to target for all engagements.

APPENDIX C

RECAPITULATION OF ALL ANSBACH TRIAL EXERCISES BY MISSION

APPENDIX C

RECAPITULATION OF ALL ANSBACH TRIAL EXERCISES BY MISSION
(Appendixes D, E. extrapolated)
HEADINGS USED

TRIALS: Number of trials

MISSION: Self explanatory

MIX: Scouts/AH-1Q (Number Participating)

ED: Exercise duration (Hours. Minutes: Seconds') First shot fired to last shot fired by either protagonist. This does not include loiter or movement times.

AH: Attack Helicopters (Number Participating)

TOW: Number of TOW's fired by all AH's participating.

TOW AVG: Average number of TOW's fired per AH per engagement.

MFT: Missile Flight Times (Total time in seconds from launch to target impact or miss.)

AVG: Average missile flight times (in seconds)

LOSSES:
- AH: Attack Helicopters destroyed
- KT: Enemy tanks destroyed (Theoretically: simulated T-62 killed)
- KA: Enemy air defense (AD) weapons destroyed (Theoretically: simulated ZSU-23-4 killed)
- TOT: Total KT and KA destroyed (killed)

TOW MISSES:
- -t: Near (close miss of tank)
- mt: Missed tank
- ma: Missed AD weapon
- m: Missed unknown target (either tank or AD)
- TOT: Total targets engaged (tank and AD)

RANGE TOTAL: Total ranges (in meters) of all targets engaged by AH-1Q's

AVG: Average range (meters) of each target engagement

APPENDIX C

RECAPITULATION OF ALL ANSBACH TRIAL EXERCISES BY MISSION
(Appendixes D, E Extrapolated)

TRIALS	MISSION	MIX	ED	AH	#TOW	AVG	MFT	AVG	LOSSES AH:	LOSSES KT	LOSSES KA	LOSSES TOT	TOW MISSES -t	TOW MISSES mt	TOW MISSES ma	TOW MISSES m	TOW MISSES TOT	RANGE TOTAL	AVG
10	DELAY	2/1	2.32:05'	10	32	3.20	04:16'	:08.00'	Ø	16	3	13	1	4	Ø	8	13	62,800	1963
									(1 scout)										
10	"	0/2	2.01:22'	19	37	1.95	05:27'	:08.84'	2	15	6	21	Ø	1	2	13	16	76,500	2068
TOTALS 20			4.33:27'	29	69		09:43'		2:	31	9	40					29	139,300	
MEANS	—					2.4		:08.5	1:	15.5	4.5								2015
10	DEFEND	2/1	1.02:22'	10	23	2.30	04:04'	:10.61'	2	12	1	13	Ø	2	4	4	10	53,000	2304
									(1 scout)										
10	"	0/2	1.33:23'	20	44	2.0	04:54'	:06.68'	1	29	3	32	Ø	7	2	3	12	63,300	1439
TOTALS 20			2.35:45	30	67		08:58'		3:	41	4	45					22	116,300	
MEANS						2.2		:08.0'	1:	13.7	1.3								1872
10	BREAKTHROUGH	2/1	4.34:44'	10	59	5.9	09:29'	:09.64'	Ø	33	3	36	Ø	Ø	1	22	23	129,600	2197
									(2 scouts)										
10	"	0/2	7.33:56'	19	103	5.4	15:24'	:08.97'	6	59	10	69	Ø	Ø	2	32	34	216,400	2101
TOTALS 20			12.08:40'	29	162		24:53'		6:	92	13	105					57	346,000	
MEANS						5.6		:09.2'	1:	15.4	2.1								2149

APPENDIXES D AND E

RECAPITULATION OF ALL ANSBACH TRIAL EXERCISES BY AIRCRAFT MIXES

APPENDIXES D AND E

RECAPITULATION OF ALL ANSBACH TRIAL EXERCISES BY AIRCRAFT MIXES
HEADINGS USED

MIX: Number- Observation Helicopter (OH)/Attack Helicopter (AH)

MSN: MISSION/DL-Delay; DF- Defend; BT- Breakthrough

TR: TRIALS/ Number of Trials conducted for each type of mission

A/C: Number and type (OH/AH) of aircraft participating

TOW: Number of TOW missiles fired during the 10 trials conducted for each type of mission.

LOSSES: OH, AH, KT-enemy tanks destroyed (Theoretically: simulated T-62 killed)

KA- Enemy air defense (AD) weapons destroyed (Theoretically: simulated ZSU-23-4 killed)

TOT: Total KT and KA destroyed (killed)

MISSES: m- miss (tank or unknown); ma- miss AD weapon; TOT- total enemy weapons missed

RANGE TOTAL: Total ranges of all TOW engagements by mission

AVG Range: Average range of all TOW engagements for all missions and trials

TOT ED: Total exercise duration by mission (hour. minutes: seconds'). Does not include loiter or movement times.

TOT MFT: Total missile flight time by mission (time in seconds from launch to target impact or miss)

(Information on helicopters engaged by enemy weapons systems)

Simulated weapons system (maximum effective range) (B78:18/D1:15-3)

U/A: Number of helicopters engaged and simulated minimum/maximum engagement ranges (under attack)

K: Number of helicopters destroyed (killed) and simulated minimum/maximum engagement ranges

APPENDIX D

RECAPITULATION OF ALL ANSBACH TRIALS BY 2 OH/1AH MIX

MSN	TR	A/C OH	A/C AH	# TOW	LOSSES AH	LOSSES OH	KT	KA	TOT	MISSES m	MISSES ma	MISSES TOT	RANGE TOTAL	AVG RANGE
DL	10	20	10	32	Ø	1	16	3	19	13	Ø	13	62,800	
DF	10	20	10	23	2	1	12	1	13	6	4	10	53,000	
BT	10	20	10	59	Ø	2	33	3	36	22	1	23	129,600	
TOTAL	30	60	30	114	2	4			68			46	245,400	2153

MSN	TOT ED	TOT MFT
DL	2.32:05'	04:16'
DF	1.02:22'	04:04'
BT	4.34:44'	09:29'
	8.09:11'	17:49'

Every 27.5' - TOW Fired
TOW HITS (68) = 60%
TOW MISSES (46) = 40%

AH's ENGAGED BY THE ENEMY BY MISSION
(Data not published by source for OH's)

MSN	U/A	ZSU 23-4 (3000m)	K		U/A	12.7mm MG (1000m)	K
DL	1	1900	Ø		5	1500 1800	Ø
DF	3	1900 2600	2	2100 2700	4	1400 1700	Ø
BT	3	1800 3500	Ø		5	1500	Ø
TOTAL	7		2		14		Ø

% LOSSES AIRCRAFT

OH 60:4 = 7%
AH 30.2 = 7%
TOTAL = 14%

(80:Appendixes A,B)

APPENDIX E

RECAPITULATION OF ALL ANSBACH TRIALS FOR 2 AH's

					LOSSES			MISSES			RANGE	
MSN	TR	AH	TOW	AH	KT	KA	TOT	m	ma	TOT	TOTAL	AVG RANGE
DL	10	19	37	2	15	6	21	14	2	16	76,500	
DF	10	20	44	1	29	3	32	10	2	12	63,300	
BT	10	19	103	6	59	10	69	32	2	34	216,400	
TOTAL	30	58	184	9			122			62	356,200	1936

MSN	TOT ED	TOT MFT
DL	2.01:22'	05:27'
DF	1.33:32'	04:54'
BT	7.33:56'	15:24'
	11.08:41'	25:45'

Every 26.0' - TOW FIRED
TOW HITS (122) = 66%
TOW MISSES (62) = 34%

AH's ENGAGED BY THE ENEMY BY MISSION

MSN	U/A	ZSU 23-4 (3000m)	K		U/A	12.7mm MG (1000m)	K	
DL	1	1600	1	1600	7	400 2800	1	400
DF	7	1200 1900	Ø		9	700 1700	1	1400
BT	13	1600 2800	5	900 2200	10	1100 2100	1	1600
TOTAL	21		6		26		3	

% LOSSES
AIRCRAFT
OH N/A
AH 58:9=15.5%
TOTAL = 15.5%

(B80: Appendixes A,B)

APPENDIX F

Criteria for Evaluating Aircraft Survivability (Vulnerability and Studies)

APPENDIX F

Criteria for Evaluating Aircraft Survivability (Vulnerability and Studies)

INPUTS: CATEGORIES	INPUTS: SUBCATEGORIES	FACTORS IMPACTING ON INPUTS
Environment Geographic Level of Conflict	terrain weather Non-Nuclear low-intensity mid-intensity Nuclear hi-intensity	Target Visibility Probability of detection/ acquistion Probability of identification Relative velocity Engagement time vs exposure time Effective range vs slant range Vulnerability of aircraft to enemy weapons & systems Aircraft tasks % of weapons available to engage aircraft
Enemy Forces	Characteristics* ADA by type SAM by type Air defense TACAIR Small arms Composition Disposition Weapons density Weapons systems Doctrine EW/ECM/ECCM** *&Capabilities	Effects of evasive actions Target presentations # Enemy intelligence Suppressive fires effects Countermeasures Multiple sortie missions vs single and multiple weapons systems Friendly (US) intelligence Variability of factors Other (USAF, USM, USMC) Forces** Terrain Flying** Other time factors
Friendly Forces	Aircraft types Manner of employment Mission profiles Doctrine Vulnerability Intelligence** EW/ECM/ECCM**	# Types of: (1) Radar cross-section (2) Visual silhouette:profile front, rear, above and below (3) Infrared emissions (4) Noise (5) Electro-optic reflectivity ** (C14:49)

NOTE: None of the survivability/vulnerability models evaluated or reviewed professed to provide relative probabilities. The majority were designed to provide finite information within limited parameters.

(D3:3-7 thru 4-9)

APPENDIX G (2 pages)

Target Acquistion Data

APPENDIX G (1 of 2 pages)

Target Acquistion Data

1. Tactical Effectiveness Testing of Antitank Missiles (TETAM) Evaluation (B72:Extracts)

a. Intervisibility Analysis (B72:x-xii,II-1-117)

TERRAIN SITE	DETECTION OPPORTUNITIES at 3000 meters	TIMES EXPOSED	MEAN EXPOSURE LENGTHS (meters)	EXPECTED MISSILE FIRINGS (Tank at 10mph)
Fulda Gap	many	2 to 4	268 to 555	4.7
North German Plain	few	1 to 4	73 to 250	2.0

(Initial sighting ranges are terrain site dependent.)

b. Random Detection Probabilities for Exposed Tank (B72:xi-xiii)

OBSERVERS	PROBABILITIES RANGES Fulda Gap (Mean)		North German Plain (Mean)	
one-	.13 to .64	(.39)	.05 to .29	(.17)
two-man team	.21 to .84	(.53)	.09 to .41	(.25)
four-man team	.32 to .94	(.63)	.17 to .52	(.35)

(Highly dependent upon number of observers in the weapons crew and length of time the threat vehicle is exposed.)

c. Engagement Probabilities (B72:xi-xiii,II-1-117 thru II-1-119)

Enemy Tank Exposed one Time at __ Miles Per Hour (mph)

TERRAIN SITE	PREVIOUSLY DETECTED YES (5mph)	(10mph)	(15mph)	NO (10mph) # of observers 1	2	4	MEDIAN EXPOSURE DURATIONS (15 mph)
Fulda Gap	.70	.56	.32	.22	.33	.44	54 seconds
North German Plain	-	.30	-	.10	.15	.20	27 seconds

Probability of engagement is extremely sensitive to handoff time. Probabilities of target engagement fall off sharply during the first 20-seconds of search after target exposure. They eventually decrease by a factor of one-half during target handoff times of 88-seconds at the Fulda Gap and 66-seconds at the North German Plain. Handoff can be effectively accomplished only by observers in the immediate vicinity of the antitank guided missile system.

NOTE: To detect, identify, locate, and fire at a target; the times range from 3-seconds to approximately 195-seconds with a median of 28-seconds for the TOW. This does not include initial burn or missile flight times.

APPENDIX G (2 of 2 pages)

TARGET ACQUISTION DATA

2. TETAM (B75:Extracts)

a. Probability Equation

P (target engagement) = P (detection) X P (successful crew response)

NOTE: Approximately 8% of the maximum number of engagement opportunities are eliminated due to missile guidance times. (B75:xvi) (i.e., During the missile's flight time, the moving target either purposefully or inadvertantly gets behind cover and/or concealment.)

b. Engagement ability parameters of antitank crews against advancing tanks are considered to be: missile flight times, missile reload times, detection times and the number of observers searching for a target. (B75:xiv)

c. Sequential events required to engage an exposed target are: target exposure (intervisibility with the ATGM site); target detection by the ATGM crew; placing the weapons sight on the target and firing; and guiding the missile to impact before line of sight is lost. (B75:xiv-xvi)

APPENDIX H

INTERVISIBILITY ASPECTS

APPENDIX H

INTERVISIBILITY ASPECTS

1. Clear lines of sight between a hypothetical laser designator and a maneuvering tactical target were frequently interrupted by dust, smoke, ground depressions, and foreground vegetation...the average durations of clear lines of sight were 29.8 seconds and 46.3 seconds. Both sets of data were taken from vantage points that were approximately 240-feet above the general elevation of the battlefield activity. The duration of clear lines of sight is also dependent on the...avenue of approach ...rate of speed...evasive tactics.
2. During the initial stage of each battle, the aggressor force could not be observed because of the existing terrain features. Nevertheless, the dust clouds created by the tanks at 5500 meters could clearly be seen.
3. On many occasions, clear lines of sight were broken for short periods of time by the occurrence of battlefield aerosols, foliage, and terrain irregularities. The obscurations caused by battlefield aerosols ranges from 10 to 100 percent opacity. Considering all sources of obscuration the average duration of the interruptions to clear lines of sight was 38.6 seconds.
4. The aggressor armored units made frequent use of the existing foliage and terrain features to conceal their advance and to prevent excessive exposure to hostile fire. Leap-frog tactics were extensively employed; i.e., several units would rapidly advance under the covering fire of forward elements until the forward elements had been bypassed, then the same procedure would be repeated.

(B87:15-16)

APPENDIX I (3 pages)

ATTACK HELICOPTER SYSTEMS

APPENDIX I (1 of 3 pages)

ATTACK HELICOPTER SYSTEMS

Survivability and Materiel Needs

1. CDEC CONCLUSIONS. (B61:vi-ix extracts)

a. Detection and Redetection: An attack helicopter system can, using both optics and the naked eye, detect or redetect tracked vehicles in a timely manner, at ranges up to 5000 meters when provided only general target information. Further, the time required to detect or redetect decreases as target information increases and time to redetect decreases by the addition of a computer system which provides initial gunner sight orientation. (B61:vi-vii)

b. Time from Detection to TOW Launch: An attack helicopter system requires very little time to lay on a target once detection occurs. The vast majority of exposure time is devoted to detecting the target and guiding the missile to impact.

c. Gunner Tracking Performance: The gunner tracking accuracy was sufficient to have achieved a hit at 2 or 3 km. Gunner tracking accuracy between systems was not significantly different.

d. Scout Added to the Threat (SCAT) Experiment: A scout helicopter operating near the FEBA at NOE, employing frequent pop-ups to 300 feet AGL, does not provide assistance to AD weapons in detection of attack helicopter systems.

e. Size and Detectability (SAD) Experiment.

(1) Findings: The OH-58 scout was the most difficult to detect, the Cheyenne the second most difficult, and the UH-1 and Cobra the easiest when unmasked at a headon hover for 60 seconds against both terrain and sky background and at ranges of 1500 meters and 300 meters.

(2) Conclusions: Detectability of a helicopter is not necessarily a function of size. Detectability is highly dependent on sun reflecting off the canopy and other bright exposed surfaces of the helicopter. Maximum effort must be expended to provide the combat helicopter with non-light reflective outer surfaces.

f. MATERIEL NEEDS: An improved stabilized optical system similar to the XM127 and Cheyenne is a must for the Army's advanced attack helicopter. A ranging device for the attack helicopter is a must in order for it to stand off at long ranges and yet insure targets are within weapons range. Camouflage must be improved in the areas of canopy glare and rotor flicker, and probably the most important materiel need is an extended range, launch and leave type missile. When reviewing the overall median exposure times of the candidate attack helicopters in Phase IV over 40 percent of that exposure time was necessary for simulating the TOW launch and holding the sight on target until impact.

APPENDIX I (2 of 3 pages)

ATTACK HELICOPTER SYSTEMS

Survivability and Materiel Needs

2. CDEC CONCLUSIONS. (B62:1-1-4 thru 1-1-5 extracts)

a. The detectability of an OH-58 helicopter, when presented against a terrain background, is increased significantly as a result of canopy glint; there was no significant difference in the detectability of an AH-1G helicopter when presented against a terrain background. The effect of canopy glint was not significant in the detectability of either helicopter when presented against a sky background.

b. Lateral movement of either helicopter tested generally increases the detectability and decreases the time required for detection.

c. A dismounted ground observer scanning a 60° search sector is generally more effective in detecting helicopters than an observer scanning a 120° search sector.

d. When two helicopters are spaced greater than 500m apart, the detection of both helicopters by a dismounted ground observer is less compared to the detection of at least one of them, or of both helicopters spaced less than 50m apart.

e. The frequency of detection was not affected significantly by the time interval, i.e., 30 or 60 seconds between pop-ups.

f. The detectability of an AH-1G using the same position for a second pop-up is not significantly different from that of an AH-1G doing a second pop-up from an alternate position separated from the first by a distance of 200 to 400m. When, however, ground observers used a 60° search sector, the OH-58 helicopter detectability was significantly less with the second pop-up at a different location from the first.

g. The OH-58 helicopter with IR suppressant paint is detected less frequently in the test environment than the OH-58 with standard paint.

h. The most frequently reported detection cues during the experiment were rotor flicker, canopy glint, movement, color contrast, and shape of the helicopter. These cues continue to be associated with helicopter detectability.

3. MASSTER CONCLUSIONS. (B89:1-3 extracts)

a. The 3 LOH-5 attack helicopter mix is the preferred task organization for the platoon when performing the daytime attack helicopter platoon missions examined in this test.

DA Comment: This conclusion tends to confirm the results of previous experiments which gave indication of a preferred 2-4 mix of LOH and attack helicopters. The 3-5 mix, therefore, would provide a 2-4 mix for combat operations at a high availability rate.

APPENDIX I (3 of 3 pages)

ATTACK HELICOPTER SYSTEMS

Survivability and Materiel Needs

3. MASSTER CONCLUSIONS. (B89:1-3 extracts) (continued).

b. The ambush tactic enables the platoon to gain the advantage over moving enemy ground elements by more effective use of the terrain and by minimizing exposure during movement to firing positions.
DA Comment: Concur.

c. The sunlight reflected by aircraft canopies and rotor blades constitutes a significant means by which ground elements may detect the aircraft.
DA Comment: The effort to reduce reflection should not be confined to only the canopies and rotor blades, but should consider the entire aircraft surface. AMC has been tasked to pursue the solution of the problems of glare and reflection associated with the surface of Army aircraft.

d. An organic area-fire capability that will disable "thin-skinned" vehicles, and force armored vehicles to "Button up" would complement the tube-launched, optically-sighted, wire-guided weapons (TOW) system with which the ACAP was assumed to be armed.
DA Comment: This judgement seems logical; however, since no supressive weapon was used or simulated by the ACCBI test results.

e. The platoon requires a practical means to quickly conceal or camouflage its aircraft while located at the forward base.
DA Comment: Concur.

APPENDIX J

TOW Vulnerability Data

APPENDIX J

TOW Vulnerability Data

Tactical Effectiveness Testing of Antitank Missiles (TETAM) Evaluation (B72:Extracts)

1. Probability of TOW being acquired as a target by overwatch (O) or advancing (A) enemy tanks.

# ENEMY VEHICLES	LAUNCH SIGNATURE		AVG RANDOM SEARCH TIME			
	Fulda Gap	N. German Plain	Fulda Gap		N. German Plain	
			O	A	O	A
			42	61	49	102
1-over watch (O)	.034	0.020				
1-advancing (A)	.025	0.008				
3-O/2-A	.14	.07				

NOTE: (1) Target range has no effect on the search times for random detections by stationary tankers; however, it does have an effect on random search times for moving tankers.
(2) The search times for random detections by overwatch crews on Fulda Gap are lognormally distributed.

2. Means:

Visual signature times from launch to pinpoint in seconds (B72:xi-xii)

	Fulda Gap		North German Plain	
	O	A	O	A
1-tank crew	17	21	16	24
Random search times in seconds				
1-tank crew	50	73	54	118

The probability that a tank crew can engage the TOW on an M113 during its firing cycle which consists of moving from defilade to an exposed position, firing, guiding the missile for 10-seconds, and returning to defilade which results in a mean exposure time of 37.3-seconds is .32 for the overwatch tank and .19 for the advancing tank. (B72:xii)

3. Conclusions: From data collected, the chances of an individual tank crew pinpointing a stationary ATW position as a result of launch signature is less than 4-percent and through a complete firing cycle is 32-percent. Consequently, in a one-on-one environment, tank crews cannot readily detect and pinpoint exposed ATW positions. (B72:xiii-xiv)

APPENDIX K

AH-1Q and OH-58Q LOGISTICAL COSTS

APPENDIX K

AH-1Q:OH-58Q LOGISTICAL COSTS

1. Annual flying hour program of 840 hours (hrs) per aircraft in a TOE (Table of Organization and Equipment) active combat environment. (B13:1-16)

2. Costs per flying hour are derived from parts; petroleum, oil and lubricants (POL) and maintenance man hours.

   a. Parts are established at $54 for the AH-1Q and $31 for the OH-58Q (x 2 = $62). (B13:4-1)

   b. POL costs are based on $ .104 per gallon for JP4 and computed as fuel consumption per hour (97 for the AH-1Q and 29 for the OH-58Q). Oil costs $1 per quart and consumption is .4 for the AH and .2 for the OH quarts per hour. (B13:2-139)

ITEM	AH-1Q	OH-58Q	(2 each)
Fuel	$10.09	$ 3.02	$ 6.04
Oil	.40	.20	.40
TOTAL per hr	$10.49	--	$ 6.40

   c. The direct and indirect (40-percent of the direct) maintenance manhours (M/H) including organizational (OM), direct support (DS) and general support (GS) maintenance per flight hour are 8.85 for the AH-1Q and 5.74 for the OH-58Q. (B13:2-141) Using an arbitrary figure of $5 per M/H, the cost of maintenance M/H's per flight hr is $44.25 and $28.70 respectively.

   d. The attrition factors for a monthly world-wide rate are .0021 for the OH-58Q and .0031 for the AH-1Q in peacetime. (B13:1-17) The peacetime annual flying hour program is 240 hrs per aircraft or 20 hrs per month. (B13:1-16) Computing the attrition factor per flight hour using the nonrounded acquisition costs from TABLE 6 (pp. 40), results in the attrition costs of $98.84 (.000155) for the AH and $56.38 (.00021) for the two OH's per flight hour.

APPENDIX L

AH-1Q:OH-58Q DEPLOYABILITY COSTS

APPENDIX L

AH-1Q : OH-58Q

Deployability Costs: Man Hours (M/H), Elapsed Time (ET)

ITEM	AH-1Q	OH-58Q
C-130 Aircraft (# loaded)	NA	(2)
Disassembly (Crew, M/H)	-	18
ET	-	1
Reassembly (Crew, M/H)	-	10.5
ET	-	1
Subtotal	NA	30.5
TOTAL COST @ $5 per hour	-	$152.50
C-141 Aircraft (# loaded)	(2)	(4)
Disassembly	60	18
	4	2
Reassembly	70	21
	5	2
Subtotal	139	43
TOTAL COST	$695	$215
C-5A Aircraft (# loaded)	(12)	(13)
Disassembly	24	18
	2	1
Reassembly	40	21
	3	1
Subtotal	69	41
TOTAL COST	$345	$205
Surface Shipment (# loaded)	(24)	(24)
Disassembly	50	32
	24	24
Reassembly	10	8
	10	12
Subtotal	94	76
TOTAL COST	$470	$380

NOTE: Numbers of helicopters per aircraft or ship can be increased by further disassembly. (B12:2-120 thru 2-123/B115:A-20,A-21) An arbitrary figure of $5 per M/H was chosen for comparison purposes only.

APPENDIX M

GLOSSARY

APPENDIX M
GLOSSARY (1 of 4 pages)

For acronyms or abbreviations not included in the list below, the reader is referred to the bibliographical alphanumeric references A8, B5, B6 and B21 or any of the standard desk dictionaries.

Acronyms

AAH- Advanced Attack Helicopter

A/C- aircraft

ACCB- Air Cavalry Combat Brigade

AH- attack helicopter

ASE- aircraft survivability equipment

ATH- antitank helicopter

AT- antitank

ATW- antitank weapon (s) (German)

CACDA- Combined Arms Combat Developments Activity (U.S. Army)

CDEC- Combat Developments Experimentation Command (U.S. Army)

CGSC- Command and General Staff College (U.S. Army)

FPM, fpm- feet per minute

HIGE, IGE- hover, in ground effect

HOGE, OGE- hover, out of ground effect

ICAM- Improved Cobra Agility and Maneuverability

IR- infrared

MASSTER- Modern Army Selected Systems Test, Evaluation and Review (U.S. Army)

MBFR- Mutual Balanced Force Reductions (talks)

M/H- maintenance man hours

NOE- nap-of-the-earth flight

R&D- research and development

SALT- Strategic Arms Limitation Talks

S/L- sea level

T-O- takeoff

APPENDIX M
GLOSSARY (2 of 4 pages)
(continued)

TDC- tank destroyer gunship (German)

TETAM- Tactical Effectiveness Testing Antitank Missiles (U.S. Army evaluation)

TRADOC- Training and Doctrine Command

UNK- unknown

w/, w/o- with, without

Other Terms

agility- ability/capability to move in all directions

AH-1G- Cobra helicopter gunship using a variety of weapons systems

AH-1Q- TOW-Cobra antitank helicopter designed to carry up to eight TOW misseles in conjunction with other weapons systems

AH-56A- (AAFSS, Cheyenne) a compound heavy attack helicopter originally designed to provide a quantum jump in technology. Development program was cancelled in August 1972 due to costs. The remaining aircraft are now used for test platforms.

"Big Five Developments"- U.S. Army's 1973 concept for major systems acquisition of the MICV- mechanized infantry combat vehicle; XM1-Abrams main battle tank; AAH- advanced attack helicopter; UTTAS- utility tactical transport aircraft system and the SAM-D surface-to-air missile development. (B15:126-127)

Cobra- see AH-1Q above

Cheyenne- see AH-56A above

engagement- "the ability to get a missile out to the immediate location of of the target." (B74:ix)

flight endurance- range and time on station capability determined by the variables of fuel capacity and fuel consumption in conjunction with altitude, temperature, speed, type flying activity and mission weight.

gross weight- total aircraft weight which includes POL, crew, armor, weapons and disposable ordnance.

"hi-lo" force mix- DOD concept of having "...a small number of high-performance, sophisticated weapons capable of coping with the maximum enemy threat and a larger number of less sophisticated and less expensive but capable weapons for countering the lower capability enemy threats." (B39:223)

APPENDIX M
GLOSSARY (3 of 4 pages)
(continued)

Intervisibility- "the existence of a line of sight between the antitank weapon system and an enemy target when an opportunity exists for the antitank weapon to engage the enemy target." (B72:II-1-9) (i.e., A clear missile flight path from the ATGM site to the target as opposed to line of sight detection such as through trees and brush.)

Kiowa- OH-58A, Army standard A light observation helicopter (LOH)

maneuverability- see agility

mid-intensity conflict- Generally oriented towards the European or Mid-East geographical areas of the more developed nations. Consists of a nonnuclear, non chemical and nonbiological conflict with national policy limitations; highly lethal, sophisticated environment using latest technological advances in weaponry; large numbers of armored forces with rapidly changing battlefield conditions.

night capability- ability to operate at night without any degradation in performance

OH-58A- see Kiowa above

OH-58Q- hypothetical OH-58A equipped with four TOW missiles and converted to a pure antitank role

probability (P)- "The number of times something will probably occur over the range of possible occurrences, expressed as a ratio - IN ALL PROBABILITY very likely." (A8:1132) The ratio is normally expressed as a decimal portion of one (1) which can be converted to a percentage by simply moving the decimal two places to the right. (e.g., APPENDIX G shows a .70 or 70% probability of engaging a previously detected tank moving at 5 miles per hour in the Fulda Gap).

probability of engagement- "provides a quantitative measurement of the chance that the target will be exposed long enough for the ATW crew to complete the process of target acquisition, firing, and missile guidance to the target's position." (B72:II-1-42)

radar cross section- An object's specific type of signal indication or radar image reflected from the energy transmitted by a primary radar. Primarily determined by the size, shape, movement, weight or mass of the object.

SA-7 Grail or Strella- USSR shoulder-fired, infrared tracking antiaircraft missile with a 3500-meters unclassified range

terrain flying- combination of nap-of-the earth (NOE), contour and low-level flight, frequently maneuvering under the wires and trees at three-feet skid height above the terrain.

TOW Cobra- see AH-1Q

APPENDIX M
GLOSSARY (4 of 4 pages)
(continued)

TOW Kiowa- see OH-58Q

weather capability- ability to operate under all weather conditions without any degradation in performance

ZSU-23-SP4 (ZSU 23-4)- USSR self-propelled quad-23mm antiaircraft artillery (AAA) weapons system with an unclassified 2500-meters visual range and 3500-meters radar range.

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